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Review Article

Nanorobots: The future of precision medicine and targeted therapeutics

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Abstract

Nanorobots are little devices that can carry out certain cellular and molecular functions. Modern nanorobots, which are based on Feynman's 1959 notion, combine biochips, nano-assemblers, and biohybrid systems to function in biological settings while utilizing either internal or external power sources. They have promise uses in the treatment of illnesses including cancer, targeted medication delivery, and diagnostics. While clottocytes and chromallocytes aid in hemostasis and gene therapy, devices like respiratory cells and pharmacytes improve oxygen transport and precisely distribute medications. Despite their great accuracy and efficiency, nanorobots have drawbacks such as expensive development, intricate design, and moral dilemmas. The development of nanorobots is being accelerated by developments in 3D printing and biohybrid technologies, which position them as a game-changing instrument in medicine and other fields.

Keywords: Nanorobots, Drug Delivery Systems, Nanotechnology, Diagnostics, Neoplasms, Surgical

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1. Introduction

The word "nano" derived from the Greek word for "dwarf," nanotechnology has seen substantial development since its inception. Nobel-winning physicist Richard Feynman established the discipline in 1959 with his groundbreaking lecture, "There's Plenty of Room at the Bottom," in which he predicted a day when robots will be able to control atoms and molecules. A student from a scientific institution in Tokyo first used the phrase "nanotechnology" in 1974. Today, it refers to the study, design, manufacturing, and manipulation of materials and systems at the nanoscale. With an emphasis on real-world applications in a variety of domains, most notably nanomedicine, this topic investigates the atomic and molecular actions of matter.[1.]

Advanced computational tools and sensing devices may be used to design, manufacture, and control nanorobots, an essential component of this discipline. These human-like robots have the potential to replace human work, particularly in dangerous settings.[2] The creation and research of nanoscale robots, which are usually between 0.1 and 10 microns in size, is the focus of the nanorobotics subfield of nanotechnology.[2.]

Nanomedicine, or the combination of nanotechnology with medicine, has produced nanorobots that have the potential to completely transform the way that diseases are treated. With possible answers for the management and treatment of illnesses, particularly cancer, these developments have acquired a lot of attention in the previous several decades. For instance, medicinal nanorobots have already undergone testing in living things and in vitro, and it is anticipated that they will develop into extremely sophisticated tools that can carry out intricate medical tasks like tumor therapy and targeted drug administration.[3.]

Micro and Nanorobotic's multidisciplinary nature combines disciplines including mechanical autonomy, data science, biomedical engineering, and nanotechnology. With further development, these robots could be able to function within the human body using external energy sources like electromagnetic fields, light, or ultrasound. It is expected that

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these advancements will affect manufacturing, information security, nanoassembly, and healthcare.[4]

The high development costs, the difficulty of creating nanoscale robots, and their vulnerability to interference from outside electrical fields are some of the issues that must be resolved. Notwithstanding these difficulties, research on nanorobots is a fascinating field because of its prospective advantages, which include increased durability, quicker operation, and tailored drug administration. Complex molecular machines for industrial and medicinal purposes appear to be becoming more and more feasible as Nano biotechnology, Nano electronics, and genomics develop.[5]

The purpose of this study is to examine the present status of nanorobots in medicine, namely in the treatment of cancer, as well as the potential uses for them in the future. The review will emphasize the potential of nanorobots to revolutionize precision medicine and provide new avenues for targeted therapeutics by summarizing recent advancements and talking about the difficulties that lie ahead.

2. History

November 29, 1959 The famous "There's Plenty of Room at the Bottom" speech is given by Richard Feynman. Concepts of nanotechnology are first presented. Exploits the possibility that individual atoms and molecules can be controlled.[4,5,18,16]

1974 definition by Norio Taniguchi, educator: The division, union, and twisting of materials by particle/atom. In 1980's: Scholars such as Dr. Eric Drexler wrote several well-researched papers favoring nanoscale science and technology. In the 1980's Nobel laureate, Richard Smalley. Smalley took his vision further to even develop super connectors in the form of Sumio Iijima-discovered carbon nanotubes, of tomorrow's ultra-small devices.[4,5,16,18]

Heinrich Rohrer and Gerd Binnig at IBM Zürich in 1981. The scanning tunneling microscope was created by him. This is used to image surfaces at the atomic level and determine some of their characteristics, like energy. The discovery of fullerenes, or molecules made completely of carbon, occurred in 1985. They are widely used in nanotechnology, electronics, and materials research.[16]

The self-replicating nanorobots described in Dr. Eric Drexler's book Engines of Creation: The Coming Era of Nanotechnology, published in 1986. This is the first book to discuss nanotechnology. [4,5,16,18]

1991: Direct result of fullerenes: discover carbon nanotubes (cylindrical fullerenes) that exhibit great tensile strength, characteristic electrical behavior, and high efficiency in heat conductivity. Electrical properties render them ideal components for circuits (transistors, ultra-capacitors).[16]

In 1991: The atomic force microscope AFM is discovered. To date, one of the most effective technologies for picture taking, measurement, and manipulating materials at the nanometer scale. It works in a mechanical probing of feeling the surface. Since one can get accurate contact by it with minute materials it is a nanorobot by classification.

The US National Nanotechnology Initiative was created in 2000 to coordinate federal efforts in nanotechnology research and development. This is a significant investment in nanotechnology.

In 2000: Incubate the firm Nanofactory Collaboration. Set up a research agenda to design a nanofactory that can produce nanorobots for medical purposes.[16]

2.1. Ideal characteristics

1. The components of nanorobots can range in size from 1 to 100 nm, and their sizes range from 0.5 to 3 microns. Capillary flow will be blocked by nanorobots bigger than those mentioned above.
2. The passive diamond shell of it protects against immune system attack.
3. This can be excreted naturally or via active scavenger systems after completion of the mission.[4,8,20]
4. The apparatus communicates with the doctor through acoustic signals that have a carrier wave frequency between 1-100 MHz.
5. Self-replication enables the production of more copies to replace worn-out units.

2.2. Advantages

1. Avoids undesired side effects by deactivating the drug in areas that require no treatment.
2. Nanorobots are at most 3 microns in size; they easily pass in the body without blocking capillaries.
3. Cheap (if mass produced): Although initial development expenditures may be substantial, batch processing lowers costs.
4. It calls for less post-treatment care because it has minimal invasive nature.
5. Nanorobots can carry and release drug molecules, thus offering greater interfacial areas during mass transfer.[1]
6. The therapeutic agents' inability to degrade. even in the future .
7. The main advantage of nano robots is believed to be their lifespan; in theory, they may function for years, decades, or even centuries.
8. Less risk and no operation failures.[19]

2.3. Disadvantages

1. It must be designed in a way that the Nano robot does not cause injury accidentally.
2. Original design cost is high.
3. Design is complicated.
4. Difficult to design.
5. Regulatory concern.
6. If it causes harm to the food chain.[19]

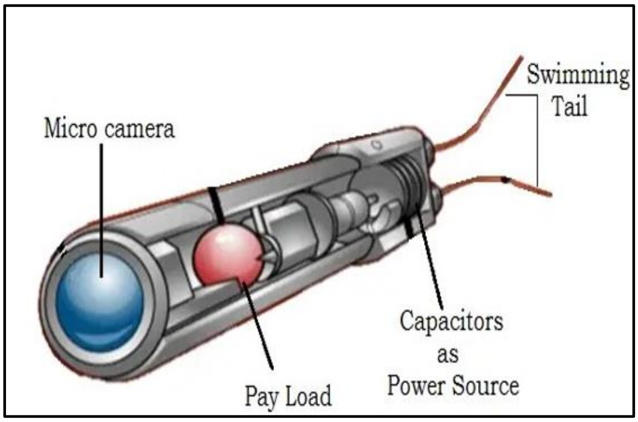

Figure 1: Structure and design of nanorobots[2]

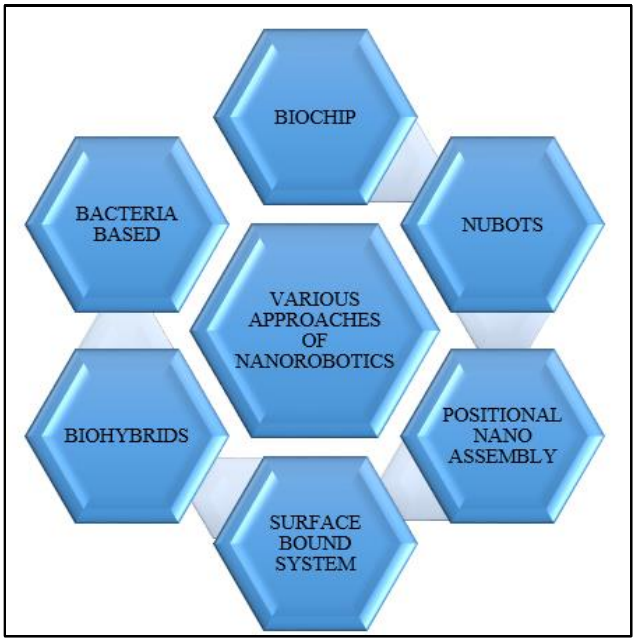

Figure 2: Approaches of nanorobotics[14]

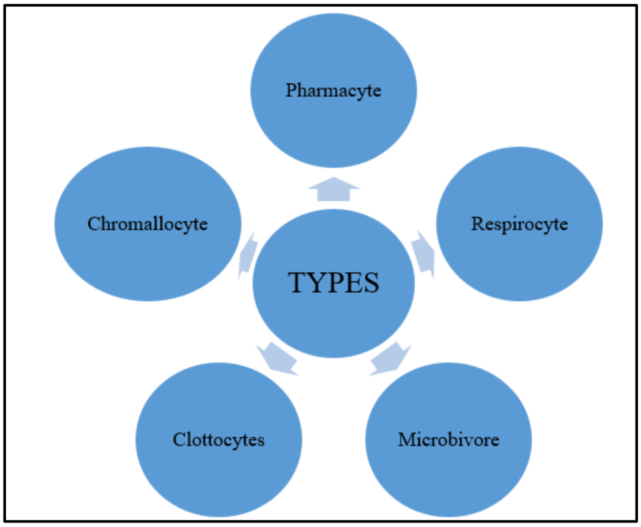

Figure 3: Types of nanorobots[19]

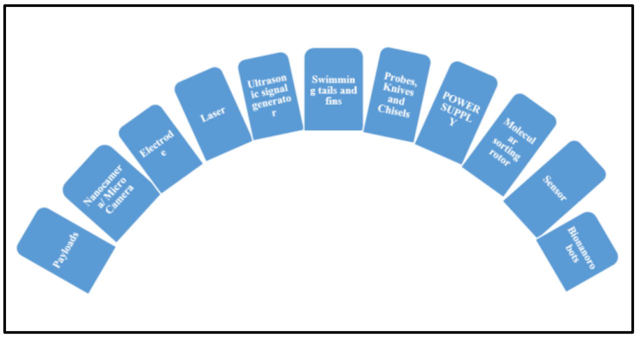

Figure 4: Components of nanorobots[1,5,7-9]

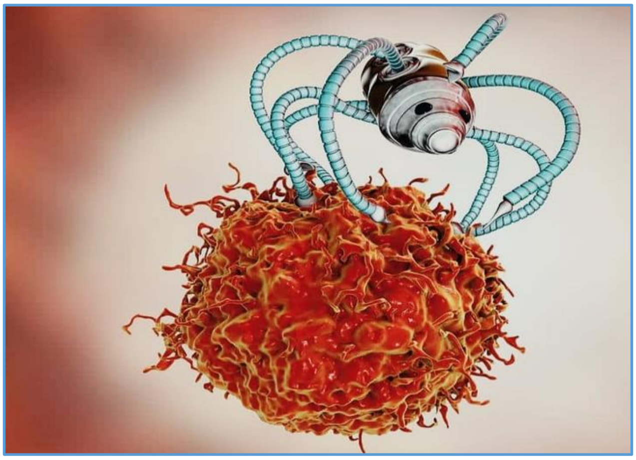

Figure 5: Cancer treatment in nanorobots

Figure 6: Nanorobots in gene therapy

Figure 7: Nanorobots in drug delivery

3. Various Approaches of Nanorobotics

3.1. Biochip

It incorporates photolithography, nanoelectronics, and new biomaterials for synthesis. It can be used to produce nanorobots for general applications in medicine, such as drug delivery, surgical tools, and diagnostic imaging. Biochips are used for the production of electronics today. Nano robots with biochips can be integrated with nano electronics devices, allowing teleoperation and enhanced abilities of medical instruments.[18]

3.2. Nubots

NuBot is a short for "nucleic acid robot". Nubots are artificial nanorobots. Examples of such nubots include several DNA walkers, as reported by Nadrian Seeman's group from NYU, Niles Pierce's group from Caltech, John Reif's group from Duke University, Chengde Mao's group from Purdue and Andrew Turberfield's group at the University of Oxford.[12]

3.3. Positional nano assembly

It focuses on creating a workable research agenda with the express goal of creating a diamondoid nano factory that can create diamondoid medical nanorobots and positionally-controlled diamond mechano-synthesis. The Nano Factory Collaboration was founded in 2000 by Robert Freitas and Ralph Merkle with 23 researchers from 10 organizations and four countries.[12]

3.4. Surface bounded system

Many experiments have confirmed the attachment of artificial molecular motors to surfaces. In a macroscopic material's surface, these primitive nanomachines work like machines due to motion restrictions. Surface-grafted motors may help position and move materials on the nanoscale within a surface, rather like a conveyor belt.[14]

3.5. Biohybrids

The integration of biological and synthetic structural elements to create an emerging bio-hybrid system is useful for applications such as biomedical or robotic functions. BioNEMS contain nanoscale elements consisting of DNA, proteins, and nanostructured mechanical components. Thiol-ene e-beam resists are capable of direct writing nanoscale features that get functionalized with biomolecules on the natively reactive resist surface. Other methods employ a biodegradable substance bonded to magnetic particles, steered about the body.[14]

3.6. 3D Printing

The term 3D printing describes the process of using additive manufacturing to create an object that exists in three dimensions. The procedure is the same for nanoscale 3D printing, although it is considerably smaller. A significant improvement in 3D printing equipment precision was required to produce structures in the 5-400 μm range. In order to optimize the technique, a two-step 3D printing method that combined 3D printing with laser-etched plates was introduced.[14]

3.7. Bacteria based

This design indicates use of biological microorganisms as E. coli bacteria are used. The model, hence, uses a flagellum for the purpose of propulsion.[13]

3.8. Pharmacyte

Up to 1 μm^3 of a particular medication can be carried in tanks by the 1-2 μm-sized medical nanorobot. Mechanical sorting pump systems regulate them. For optimal targeted accuracy, they are outfitted with chemotactic sensors or molecular markers. Glucose and oxygen from the surrounding environment, including blood, intestinal fluid, and cytosol, serve as the onboard power source. After it has done with all the functions, nanorobots can then be withdrawn or recovered via centrifuge nana pheresis.[1]

It is a self-powered computer controlled medical nanorobot device that can digitally accurately transport, time, and target medicinal substance distribution to specified cellular and intracellular destinations in the human body.[19]
It may carry up to one m^3 of pharmacological payload. It will physically be offloaded with molecular sorting pumps inside the hull that can be controlled by a computer on board. These are coupled to chemotactic sensors or molecular markers to provide targeting power and precision.[2]

3.9. Respirocytes

The bloodstream carries respiratory cells, which are nanorobots that mimic mechanical red blood cells and have a diameter of 1 μm. A diamond-lined 1000 atm pressure vessel with reversible molecule-selective pumps makes up the exterior shell. The body uses respirocytes to carry carbon dioxide and oxygen. Up to 3 billion molecules of carbon dioxide and oxygen can be held in the diamond-shaped pressure tanks that house the 18 billion atoms that make up the respiratory cell. In comparison to normal red blood cells, the respirocyte provides 236 times as much oxygen to the body's tissues. Presumably, the respirocyte will control the carbonic acidity; concentration gas sensors and an internal nanocomputer will also monitor this. Using molecular pumps, the stored gases are regulatedly released from the tank. Molecular rotors are used by respiratory cells to exchange gases. For each type of molecule, the rotors have a specific tip. There are three kinds of rotors in each respirocyte. During its passage through the body, one rotor releases stored oxygen. The second kind of rotor absorbs all of the carbon dioxide in the blood and releases it into the lungs, whereas the third kind uses the blood's glucose as fuel. There are 12 such pumps positioned around the equator. On the left side are oxygen rotors, middle is water rotors, and left are carbon dioxide rotors. Respirocytes have sensors for gas concentration on their surfaces.[5]

The patient's blood is drawn for nanapheresis and placed in a centrifugation device made especially for the procedure, where ultrasonic transmitters instruct the respirocyte to take on neutral buoyancy. The blood's other solid components silt outward as centrifugation goes on because they are unable to maintain neutral buoyancy. The blood components are suspended again in the filtered plasma. The filtered plasma is blended with centrifuged solid blood components and then returned intact to the patient's body.[19]

3.10. Microbivores

These theoretical structures behave like white blood cells in the blood and have captured circulating microorganisms. Scientists speculate that phagocytes are superior to cellular blood cells. The microbivore surface has been designed so it bears processes which can extend to the appropriate length and firmly lodge upon any given microbe with which contact might occur.[19]

It is a nanomedical device with a major axis diameter of 3.4 µm and a minor axis diameter of 2.0 µm. It is possible for the nanobot to continuously use up to 200 watts. Its ability to break down confined microbes. Another distinctive feature is the ability to phagocyte about 80 times more efficiently than macrophage agents, based on volume/sec digested per unit volume of phagocytic agent.[1]

Nanorobots known as microbivores resemble synthetic white blood cells. Another name for them is nanorobotic phagocytes. With a major axis of 3.4 µm and a minor axis of 2.0 µm in diameter, the microbivore is a spheroid device composed of sapphire and diamond. It contains 610 billion meticulously arranged structural atoms. It captures and degrades bacteria in the bloodstream. The main role of a microbivore is the consumption and assimilation of pathogens in blood by phagocytosis.[8]

3.11. Clottocytes

The "instant" hemostasis provided by clottocytes, or artificial mechanical platelets, is one of the nanorobots' distinctive biological features. Platelets measure 2 µm in diameter and have a relatively spheroidal nucleus-free structure. Platelets get collected at the bleeding point. They become sticky, stick together, and build up a tampon. These help in stamping the blood artery and the stoppage of flow of blood. They also have medicines that promote coagulation.[1] It can close haemostasis in ~1 second, even in large wounds. The robots function like platelets do within blood in humans.[19]

Hemostasis: This refers to the process whereby blood clots in case the endothelium cells, which coat the blood vessel, is damaged by the platelets. When the exposed collagen from the damaged blood vessel collides with the platelets above, it can excite the platelets above. It would take roughly two to five minutes for the blood to clot naturally. The aforementioned nanotechnology has demonstrated some potential for lowering clotting time and, consequently, blood loss. Blood clots are shown to arise irregularly in certain people. Corticosteroids and other medications are used to address this condition. The treatment with corticosteroids is associated with side effects such as hormonal secretions; blood/platelet could damage lungs and allergic reactions.[8]

This technology responds 100–1000 times faster than the traditional system. A circular nanorobot fueled by serum oxyglucose, our basic clottocyte has a 2-micron diameter and a 4-micron-3 extent with a foldable fiber mesh. The gadget, which is controlled by its control computer, unfolds its mesh packet inside the vicinity of a broken blood vessel, such as after a skin cut. Soluble thin coatings dissolve when applied to particular mesh locations and subjected to plasma water, exposing sticky spots in the patterns that are desired. The blood cells attach immediately to the overlapping synthetic networks created by the large number of active clottocytes, and bleeding is quickly stopped.[2]

3.12. Chromallocyte

By replacing complete chromosomes in individual cells, the chromallocyte would reverse the effects of inherited diseases and other unintentional gene damage while delaying the aging process. In a cell, a repair machine will evaluate the situation by measuring the contents and activity of the cell, then acting molecule-by-molecule and structure-by-structure; repair machines will be able to repair the entire cel.[1]

These diamond-shaped nanorobots are highly efficient gene delivery agents. They could perhaps take alternative chromosome therapies. Its dimensions are 4.18 x 3.28 nm, and its sectional movement is 3.28 nm with a length of 5.05 nm.They consume 50-200 watts in normal and at max 1000 in peaks during the most power demanding process of messaging where they send the signal back out. A repair machine inside a cell will diagnose the problem by scanning the contents and behaviors of the cell, and then repair the entire cell molecule by molecule and shape by shape; repair machines may be able to repair the entire cell.[2]

3.13. Components

Carbon is the main material of nanorobots because it is stable, solid, and strong, resembling a diamond. Some of the other materials used in the manufacture of nanorobots include hydrogen, oxygen, nitrogen, sulfur, silicon, and fluorine. Other features include:[2]

3.14. Payloads

This is an empty area of nanorobots. It contains the antibiotic or chemical that is to be used to treat the disease. Pharmacological action is demonstrated by the nanorobot, which also finds the target spot and dispenses medication from the medicine chamber. Compared to nanorobots, traditional chemotherapy has lesser action. This is an empty space for holding a small quantity of drugs or medicine. It can move in the blood and transport the medicine to the site of disease or injury.[1,5,7-9]

4. Nanocamera/Micro Camera

The Nanorobot catches up to a microscopic camera the size of a nanometre. The Nanocamera is utilized to see and monitor the operation of the nanorobots from inside the body. They direct the nanorobots along the bloodstream channels into the targeted organ or cell.[2]

The nanorobot contains a small camera that people can see when traveling across the body manually.[1,5-9]

4.1. Electrode

It is used to generate electric current. This electric current kills the cell without affecting cells or tissue surrounding it.[2] The electrode attached to the nanorobot can possibly be used as a battery through electrolytes present in blood. These out-swinging electrodes could also kill the cancer cells by generating current and then killing them with heat.[1,5-9]

4.2. Laser

Scientists have a great challenge to develop a miniature laser beam that can be attached to nanorobots in order to destroy hazardous substance without burning surrounding tissue.[2] These lasers can burn hazardous materials such as plaque in the arteries, clots of blood, and cancer cells.[1,5-9] The laser is administered directly into the target cell and kills the cells, but no surrounding tissues or cells are killed.[2]

5. Ultrasonic Signal Generator

Cancer cells and kidney stones cause damage by producing an ultrasound or microwave signal. A Nano robot may use ultrafine microwaves or ultrasonic sig0nals to shatter the chemical bonds holding the malignant cell together in order to kill it with no damage to the cell membrane.[2,7] They are used when the nanoro,=bots target and remove kidney stones.[5-7]

5.1. Swimming tails and fins

Swimming tails aid travelling nanorobots in bloodstream against the blood flow.[2]

Nanorobots gain entrance into body through propulsion, the movement is covered under motor manipulator arms and mechanical legs. The chemical sensor is included in nanorobots to detect target molecule.[5]

Positional and self-assembly are the two main methods used in the building of nanorobots. In positional assembly, the investigators will put billions of molecules together and let them automatically assemble based on their natural affinities into the desired configuration.[9]

5.2. Probes, knives and chisels

This factor is used to break down biological obstacles such as clots and embolisms. If the clotting component is a small blocked vessel, it is broken down and entirely eradicated. It was destructive to the body.[2,10]

5.3. Power supply in nano robot

The nanorobot must be strong, which has been confirmed by several stability tests. There are both internal and external power sources for nanorobots.

External source
Nanobots need external power sources; they can be located in the human circulation and operate at body temperature.

Internal source
Nanorobots in a rechargeable battery are utilized and involved in various activities, yet the battery recharges through an internal source.[2,11]

5.4. Molecular sorting rotor

The Molecular Sorting Rotor is made of carbon nanotubes. These carry binding molecules and device binding molecules that arise from the solution. The shifting of movement direction in the body is done by Nanotubes and Nanogear. SWNT is suitable for mechanical movements.[12]

5.5. Sensor

This is the essential part of nanorobots. In external, the sensor has two prime objectives: to locate the target spot and to measure alterations of the nanorobot functional characteristics. Cantilevers and carbon paste electrodes (CPE) are one of the sensors used in the nanorobots applied for pharmaceutical and medicinal aspects.[2,13-14]

5.6. Bionanorobots

Nano robots are fabricated and functionalized by exploiting the properties of biological materials (peptides, DNA).[1]

6. Applications

6.1. Nanorobots in cancer treatment

As says World Health Organization, Cancer is the primary reason of death nowadays. Radio therapy and Chemo therapy are traditional ways of treating cancer but have loads of pain and side effects of fatigue, hair loss, weight loss etc in their treatment.[8]

Researchers have therefore developed the idea of employing nanorobots in cancer treatment in an effort to stop this. Therefore, cancer patients can receive a complete cure with no adverse effects by using nanorobots. This work presents an innovative approach to build, control and monitoring medical Nanorobot in diagnosis of cancer for its early stage before metastasis.[8]

Considering the characteristics of the nanorobots to be able to navigate as bloodborne gadgets that they can assist with such crucial elements of cancer treatment. Also the nanorobots which feature the embedded chemical biosensors are also able to be utilized to carry on the process for the detection of tumor cells in their early phases during development inside the human body.[1,15]

Nanomedicine is the inactivation of ribonucleic reductase. It is a protein-bound to cancer growth produced by the inactivating gene. Nanorobots are being developed to enhance cancer detection abilities and hasten cancer analysis, since the early diagnosis increases cancer survival chances.[1,2,4,9,16,17]

7. Nanorobots in Treatment of Diabetes

Medical nanorobots keep an eye on diabetes by regulating bodily nutrient concentrations, including blood glucose levels. To maintain glucose levels within control, diabetics have to draw small samples of blood several times each day. Such treatments are painful and inconvenient. If the right target glucose levels in the blood are not controlled, serious problems may occur. The concentration of sugar in the body may be measured by continuous glucose monitoring using medical nanorobotics.[15]

A 30 mg/dl range might be used as the displacement range. It can be modified, nonetheless, in accordance with medical directives. When building medical nanorobots, radio waves could be used to automatically send vital, quantifiable data to a patient's cell phone. Whenever the glucose level becomes critically low at any time, the nanorobot sends an alarm to the cell phone.[1,8,15,18]

7.1. Gene therapy with nanorobots

The medical nanorobot can treat genetic illnesses by analyzing the molecular structures of proteins and DNA found in cells. Chromosome replacement therapy can be done using chromallocytes.[9] Medical nanorobots can quickly treat genetic diseases by comparing the molecular systems of DNA and proteins found within the cell to defined or desired reference structures.[18]

In some cases, cyto repair is not as effective as chromosomal replacement therapy.[16]

A repair vessel created by an assembler carries out genetic alterations within a human cell's nucleus. The DNA supercoil is stretched between the bottom pair of robot arms of the nanomachine, which delicately pulls an unwound strand through the outlet in its prow for analysis. On the other hand, the regulatory proteins are added to the intake port by the upper hands after being removed from the chain. If illnesses can be addressed at the molecular level, infections, heart disease, and cancer can be prevented.[2]

Gene expression and the resulting protein synthesis are the primary determinants of cell function, and molecular malfunction at the cellular level is the root cause of the majority of human disorders Trying to overcome the overexpression resulting from these errors by applying antisense transcription silencing on a whole-body, multigene, or whole-chromosome basis would be much less desirable than developing more effective therapeutic methods that do not require such extensive remediation.[8]

7.2. Nanorobots in kidney disease

Using ultrasonic shocks, these can break kidney stones. The formation of large stone due to the kidney stones causes extreme pain. These stones do not come out in the urine. Nanorobot works on the mechanism to break these stones in small pieces, which come out in the urine.[2]

Internal pain increases with the size of the stone. A Nano robot could break up kidney stones using a small laser.[16]

It is possible that nano robots may transport a tiny ultrasonic signal generator that sends frequencies straight to kidney stones, where they would be broken down and expelled as urine. Nanorobots could be used within the body to break clots of blood into pieces before they can break away and start moving on their own. Internal kidney stones can cause pain; the larger the stone, the more painful it is to pass. A nanorobot could possibly smash up kidney stones with a small laser.[19]

8. Surgery with Nanorobots

Inside the body, the surgically programmable nanorobot might do semi-autonomous surgery. It would perform a number of tasks like detecting disease, diagnosing and repairing lesions through nanomanipulation controlled by an onboard computer.[9]

Surgical nanorobots can be injected into a human body through the system of veins or at both ends of catheters put into several veins and human cavities.[16-17]

Coronary artery disease is treated by heart bypass surgery. This improves blood flow to the heart's muscles. An electric motor, a camera, a microprocessor, an artery thermometer, and a revolving needle make up this device. The microprocessor will control the entire process.[7]

One of the body's major arteries, the femoral artery, is where the Nanorobot can be injected. The diamond chip enables the activated Nanorobot to cut the plaque and ground it into little pieces. The Nanorobot is withdrawn by instructing it to attach to a blood artery that can be easily accessed from outside.[8]

8.1. Nanorobot in gout

In gout, the kidneys are unable to eliminate waste products from the breakdown of blood lipids. This waste occasionally crystallizes at locations close to joints, such as the ankles and knees. Gout sufferers experience excruciating pain during these times. A Nano robot would break the crystalline structures at the joints, hence relieving the symptoms, but could not reverse the condition for good.[7,16,17,19]

They cannot offer patients enduring relief from the disease.[2]

9. Nanorobots in Cleaning Wounds

If you or your child has been injured, scratched, or burned, you must treat the wound as soon as possible to prevent infection. Due to their requirement for a dressing, foam dressings are not appropriate for dry wounds, dry scars that heal with exudates, or wounds with low exudates. It has an impact upon the epidermis of the body's new skin.2[2] Nano-robots can clean up the debris of a wound thereby avoiding infections. Their role will be significant in areas where there is puncture injuries and cannot be successfully cured through traditional treatments alone.[1,16]

9.1. Nanorobot in drug delivery

Drug side effects might be minimized by using nanorobots to deliver medications to precise target locations within the body. Nanomedicine applied in drug delivery involves nanoparticles that may enhance the bioavailability of the drug.[2]

9.2. Treating arteriosclerosis

It occurs when fatty material accumulates in the walls of the arteries. A dangerous heart condition is the cholesterol, WBC, and other debris accumulating in the arterial wall. Arteriosclerosis is caused by a blockage in a blood artery.[2]

Medical nanorobots can likely discover atherosclerotic lesions in blood vessels, mainly in the circulation of the coronary, as well as treat them with a physical, chemical or pharmaceutical approach.[15]

Nanorobots might potentially cure the illness by cutting away plaque, which would then enter the bloodstream.[15]

9.3. Skin disease

A nanobot lotion could treat the skin conditions. In addition to successfully completing the fundamental goal of "deep pore cleansing" by penetrating deeply into pores and clearing them out, it may remove dead skin and saps, add missing oils, and apply a complete circle degree of common drenching mixes. The cream can come with an easy to wear, strip-off feel.[4]

9.4. Aging

Chromosome segments that are damaged or miscoded can be replaced or repaired by DNA repair machinery. Other medical nanorobots that could heal cells would be those that could clean harmful, accumulated debris from human tissue cells and revive them in their youthful state.[15]

10. Nanorobotic Dentifrices (Dentifrobot)

This is a dental product, applied by use of toothbrush together with toothpaste in cleaning teeth. The main constituents include abrasive, binder, surfactant, and humectant. Also, the various components include. Nanorobots smart ones may detect food particles, plaque, and tartar which could then remove and clean off the teeth. These tiny nanorobots are mechanical apparatus which die when ingested.[2] Diagnosis and therapy highly involve nanorobotics.[8] Dentifrobots, is a nanorobots used in dental practices. These nanorobots can lead to oral analgesia, desensitize teeth, and manipulate the tissues to realign and straighten abnormal teeth.[9]

10.1. Treatment of AIDS

AIDS is not a deadly illness. Because the HIV virus may kill the immune system, it is the cause of AIDS. As a result, minor infections that have the potential to become fatal might affect the host system. The HIV virus transforms WBCs into HIV in order to assault them. Consequently, the immune system malfunctions and all WBCs transform into HIV. This is the reason the patient passed away. Our objective is to employ a nanorobot that will reverse AIDS-affected WBCs back into their normal state, thereby keeping the patient's immune system constant. Nanorobots do the opposite process of the HIV.[8]

10.2. Body surveillance

Nanorobots could deliver continuous vital monitoring and wireless communication, which would constitute a quantum leap in the diagnoses. This would further help to respond quickly to any abrupt changes in the vital parameters, or may give a warning of a potential threat, like high blood sugar in diabetic patients.

10.3. Hemophilia

One of the nanorobots is clottocytes, or artificial platelets. In the blood plasma, the tiny mesh net of clottocytes melts into a sticky membrane. According to Robert A. Freitas, Jr., the designer of clottocyte, clotting can occur 1,000 times faster than normal body clotting.[16]

10.4. As artificial neurons

One nanorobot can replace every neuron in the brain with one designed to behave like most every day, run-of-the-mill neurons. The nanotech neurons are functionally indistinguishable. They hook into the synapses of the original neuron and perform all functional activities.[16]

11. Discussion

Nanorobots have the potential to play an important role in the elimination or cure of common diseases. They will provide combine actions they help in diagnosing, treating and preventing disease, relieving pain, conserving and improving human well-being various molecular tools and molecular information of the human body. It has numerous advantages over conventional methods which include improve bioavailability, targeted therapy, less surgeon mistakes, better accuracy, fewer side effects and rapid speed of drug action. An important aspect is to achieve a successful treatment for patients is the development of efficient targeted drug delivery to decrease the side effects from chemotherapy. Nanorobots with embedded chemical biosensors can be used to perform detection of tumour cells without affecting the surrounding cells in early stages of development inside the patient's body. It is also used in removing clots and in various diseases such as diabetes, cardiovascular diseases, kidney stones, gout, atherosclerosis, and dental applications.

12. Conclusion

In conclusion, Nano medicine holds the promise to lead to an earlier diagnosis, better therapy and improved follow up care, making the health care more effective and affordable. This review demonstrates their potential to overcome the limitations of traditional nanocarriers by enabling real-time responsiveness, site-specific action, and reduced systemic toxicity. Current developments in nanotechnology, such as the development of nanobots, offer hope for the less harmful diagnosis and treatment of numerous serious illnesses, including diabetes, HIV, cancer, heart disease, and genetic disorders. Also, the fields of dentistry and surgery benefits greatly from it. However, challenges related to large-scale production, navigation control, and long-term biocompatibility remain. Future research should focus on the development of AI-driven, stimuli-responsive systems and researchers should focus on clinical models to ensure their successful transition from laboratory studies to clinical applications.

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15. Conflict of Interest

The authors declare no conflict of interest.

16. Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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