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Nanorobotics: The Future of Medicines

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ABSTRACT

Nano-robots are the technology of creating machines or robots close to the microscopic scale to nanometer. Nano-robots is a truly multidisciplinary field which comprises of the simultaneous advantage of medicinal and robots knowledge disciplines will merge including robots, and mechanical, chemical and biomedical engineering, chemistry, biology, physical science and mathematics or arithmetic. Nano-robots medicine is therapeutically more effective, individualized, dose reduced and more affordable medicine. Nano-robots medicines are being developed to improve drug bioavailability. Target drug delivery is currently the most advanced application of Nano-robots in medicine. Nanotechnology is being used to produce new generations of biomaterial scaffolds that can encourage or support cell growth and differentiation into often complex tissue types. Nano-robots medicine include targeting semi-metallic or metallic nanoparticles, e.g. silica, iron or gold, to tumor sites and then activating them by external means, e.g. light, magnetic field, ultrasound, to produce heat or soft radiation locally that can destroy the cancer cells in situ gene therapy cell therapy. Nano medicines are better imaging-techniques and other diagnostic tools Nano-robots opens up new ways for vast and abundant research work in which many. Nanorobots have strong potential to revolutionize healthcare to treat disease in future.

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INTRODUCTION:

"There's Plenty of Room at the Bottom"

~Richard Feyman

The first cinematography-inspired use of nanotechnology for medicine, different researchers, scholars, producers and creators have been depicting how this powerful technology can aid us to explore the nanoscale of the human body. However, one inquiry holds on. Where do fantasy, Creative energy and science fiction stop and where do 'real' science and medicine begin ? The answer is that despite the fact that dramatic developments in technology and engineering at the nanoscale have occurred in the last years, we are still in a state of infancy regarding the capability to design, manufacture, control, explore nanorobots and purposefully intervene for diagnosis or therapy of diseases [1].

Nanotechnology has numerous energy-related applications. Nanotechnology is the science and application of creating objects on a level smaller than 100 nanometers. The amazing idea of nanotechnology is the "bottom up" creation of virtually any material or object by assembling one atom at once. Despite the fact that nanotech processes happen at the scale of nanometers, the materials and objects that outcome from these processes can be much bigger. Large-scale results occur when nanotechnology involves massive parallelism in which many simultaneous and synergistic nanoscale processes combine to produce a large-scale result.

Many human illnesses and injuries have their origins in nanoscale processes. Likewise, application of nanotechnology to the practice of medicine and biomedical research opens up new opportunities to treat diseases, repair wounds, and upgrade human functioning beyond what is possible with macro scale techniques. At the nanoscale level, Nanoparticles can attach to certain cells or tissues and provide medical images of their location and structure. Hollow or empty nanocapsules with pharmaceutical contents can attach to cancer cells and release their payloads into them by maximizing targeted delivery and minimizing systemic side effects. Nanomedibots may repair vital tissue damaged by injury or illness, or devastate cancerous tissue that has gone ashtray, without obstructive surgery [2].

Nanotechnology as a diagnostic and treatment tool for patients with cancer and diabetes showed how actual developments in new manufacturing technologies are enabling innovative works which may help in constructing and employing nanorobots most effectively for biomedical problems. Nanopharmacology is also the application of nanotechnology to the discovery of new molecular entities with pharmacological properties. Nanotechnology is also valuable for individualized matching of pharmaceuticals to particular people to maximize effectiveness and minimize side effects. It is also used for conveyance of pharmaceuticals to targeted locations or specific types of tissue in the body [1].

Nanorobots applied to medicine hold a wealth of promise from eradicating disease to reversing the aging process (wrinkles, loss of bone mass and age-related conditions are all treatable at the cellular level) and are also candidates for industrial applications. They will give personalized medications with improved efficacy and reduced side effects that are not available today. These microscopic robots will theoretically have the capability to do things which may appear like magic. From building things out of thin air to curing diseases and even solving environmental problems, nanorobots can be standout amongst important advances mankind has ever created [1].

Ideal Characteristics

- Nanorobots must have size between 0.5 to 3 microns huge with 1-100 nm parts. Nanorobots of larger size than the above will block capillary flow.
- It will avert itself, from being attacked by the immune system by having a passive, diamond exterior.
- It will communicate with the doctor by encoding messages to acoustic signals at carrier wave frequencies of 1-100 MHz.
- It might produce multiple copies of it to replace worn-out units, a methodology called self-replication.
- After the completion of the task, it can be recovered by allowing it to exfuse themselves via the usual human excretory channels or can also be removed by active scavenger systems [2].

Types of Nanorobots

- Respirocyte (Artificial Oxygen Carrier)
- Chromallocyte (Cell-Repair Nanorobot)
- Clottocytes (Artificial mechanical platelets)
- Pharmacytes (Nanorobotic pharmaceutical drug delivery device) [2]

Components of Nanorobots [3]

Extending nanomedicine to molecular machine framework will presumably require, among numerous different things, the ability to build exact structures, actuators, and engines that operate at the molecular level, thus empowering manipulation and locomotion.

Nanobearings and nanogears

To establish the foundation for molecular fabricating, it is first important to make and to analyze possible designs for nanoscale mechanical parts that could be manufactured. Molecular bearings are perhaps the most convenient class of components to design because their structure and operation is fairly straightforward. One of the simplest examples is Drexler's over laprepulsion bearing design, shown with end views and exploded views in figure using both ball-and stick and space-filling representations. This bearing has exactly 206 atoms including carbon, silicon, oxygen, and hydrogen, and it comprises a small shaft that rotates within a ring sleeve.

Molecular gears

Molecular gears are another convenient component system for molecular manufacturing configuration -ahead. For example, Drexler and Merkle designed a 3557- atom planetary gear. The entire assembly has 12 moving parts and is 4.3 nm in diameter and 4.4 nm long, with a molecular weight of 51,009.844 Da.

Nanomotors and power sources

Another class of theoretical nanodevice that has been designed is a gas-powered molecular motor or pump. The pump and chamber wall segment contain 6165 atoms with a molecular weight of 88,190.813 Da and a molecular volume of 63.984 nm3. This device could serve either as a pump for neon gas atoms or as a motor to convert neon gas pressure into rotary power. The helical rotor has a grooved cylindrical bearing surface at every end, supporting a screw-threaded tube shaped segment in the middle.

Nanocomputers

Truly effective medical nanorobots may require onboard computers to allow a physician to properly monitor and control their work. Molecular computing has become one of the hottest research topics in nanotechnology. In 2000, a collaborative effort between the University of California, Los Angeles, and Hewlett Packard created the first laboratory demonstration of completely reversible room-temperature molecular switches that could be employed in nanoscale memories, utilising mechanically interlinked ring molecules called catenanes, and there has been much recent progress with nanotube and nanorod based molecular electronics [2].

Self-assembly of mechanical parts

Self-assembling molecular systems include those that form ordered monomolecular structures by the coordination of molecules to surfaces, called self assembled monolayers (SAMs), self-assembling thin films or Langmuir-Blodgett films, self assembling lipidic micelles and vesicles, and self-organizing nanostructures.

I. DNA-directed assembly

Working from the insight that DNA could serve as an assembly, Smith and Krummenacker devised a possible method for the assembly and covalent linkage of protein parts into specific orientations and arrangements, as controlled by the hybridization of DNA attached to the proteins, called DNA-Guided Assembly of Proteins (DGAP). In this method, multiple DNA sequences would be attached to specific positions on the surface of every protein, and complementary sequences would bind, forcing protein building blocks together in specific desired combinations and arrngements, which would then be balanced by covalent interprotein linkages. This method could also be connected to nonprotein components that can be functionalized at multiple sites with site-specific DNA sequences [3].

II. Protein-directed assembly

Ratchet-action protein-based molecular motors are well known in biological conformational cascades of a special genetic variant of yeast cell prions have already been used to assemble silver and gold particle based nanowires, and the GTPase dynamin mechano-enzyme, which self-assembles into rings or spirals, wrapping around the necks of budding vesicles and squeezing, pinching them off, during cellular endocytosis.

III. Microbe and virus directed assembly

Artificial microbes might also be employed in molecular construction. A variety of biological molecular machines are already known that display linear motions; movements related to opening, closing, and translocation functions. Regarding microbe-directed parts fabrication, one strain of bacteria (Pseudomonas stutzeri AG259) is known to fabricate single crystals of pure silver in specific geometric shapes, such as equilateral triangles and hexagons, up to 200 nm in size. Acetobacter xylinum, E. coli and Deinococcus radiodurans also used for the same.

Positional assembly and molecular structure manufacturing

As machine structures become more unpredictable, getting all the parts to spontaneously self assemble in the right sequence will be increasingly difficult. To build such unpredictable structures, it bodes more sense to design a mechanism that can assemble a molecular structure by what is called positional assembly [4].

Mechanism of action

The target has surface chemical receptors allowing the nanorobots to detect and remember it. Software or programming known as Nanorobot Control Design (NCD) simulator was developed for nanorobots for an environment with fluids dominated by Brownian motion and viscous rather than inertial forces. There are three method of mechanism of action of nanorobots.

1. By Brownian motions they find the target by random search.

2. The nanorobots monitor for chemical concentration above the foundation level. After detecting the signal, a nanorobot estimates the concentration gradient and moves toward higher concentrations until it reaches the target.

3. Nanorobots at the target release another chemical, which others use as a guiding signal to the target [5].

NANOROBOTS

A nanorobot is a tiny machine designed to perform a specific task or tasks repeatedly and with precision at nanoscale measurements, that is, measurements of a couple of nanometers (nm) or less, where 1 nm = 10^{-9} meter. Nanorobots have potential applications in the assembly and maintenance of sophisticated systems. Nanorobots might work at the atomic or molecular level to build devices, machines, or circuits, a methodology known as molecular manufacturing. Nanorobots may additionally creates copies of themselves to replace exhausted units, a process called self-replication [6].

The burgeoning field of nanotechnology has many useful and direct applications for the medical industry; and **nanorobots** are no exception to this rule. The medical science wants to make nanobots that can repair damaged tissue without pain and trauma. Invasive surgical procedures are also quite common today, with related injuries that cause many patients to die on the operating table rather than survive and heal.

Nanorobots are small to the point that they actually interact on the same level as bacteria and viruses do, and so they are capable of building with the very particles of our bodies: atoms and molecules.

The ideal nanobot have not yet been fully realized, but when this microscopic robot makes its inevitable debut it will be hailed as a lifesaver by the world of medicine.

Some might say that today’s medical advances are more than enough and that mankind should leave room for natural processes. The truth is that artificial lifestyles have given rise to all kinds of ailments that absolutely require human interference for lifesaving purposes [7].

Surgery’s attendant risks are not only inherent in the cutting and sewing done by medical staff but include drug-related dangers as well. Patients may be hypersensitive to anesthetics; their organs may become infected from a variety of surgery-related sources; during an organ transplant their body may mysteriously reject the new organ, prompting death; and on account of tumor operation, even a couple of microscopic missed cells can constitute complete failure to battle the cancer.

Drugs are little better when it comes to artfulness. In spite of the fact that they do can associate specifically with the body’s molecules and cells, they work by method for the circulatory system. Your bloodstream is an aimless cycle that delivers its contents to many parts of the body.

Any drug administered will automatically affect areas of the body that are perfectly healthy, and significant doses will all probability reason cause unpleasant side effects. This implies that the drug which is supposed to cure you may actually leave many parts of your body in worse shape than they were before. In this sense they have much the same obtuse affect as a surgeon’s scalpel, paying little mind to how refined the drug [6].

Nanorobots, on the other hand, will typically measure only about six atoms wide. It is foreseen that they could be equipped with all sorts of tools and cameras in order to furnish more extensive information about the human body. That, as well as scientists expect that someday they will have refined the nanobot design to the point where nanobots can be remotely controlled in order to perform millions of useful tasks.

Among these is the ability to float neutrally through your circulatory system identifying problem areas of your body and fixing them. Nanorobots could be utilized to clear built-up cholesterol from your arteries and saving you from a heart attack. If the heart itself is harmed, they work their way up to the affected zone and perform micro-surgery that you would probably not feel or notice, yet which would more likely than certainly save your life.

When it comes to major unsolved diseases like cancer, nanorobots are ideal for eradicating malignant cells. Scientists are now working diligently on nanobots that can identify and destroy cancer at its growth site so that no trauma is inflicted anywhere else in the body.
The capacities of nanobots include their function as replacement helper-T cells in a weakened immune system, thereby greatly benefiting victims of leukemia and AIDS as well as many other such terrible diseases.

More importantly, nanorobots' ability to interact with materials in their most basic form may enable them to effectively rebuild or "regrow" harmed tissue. In the same way that a nanorobot would be able to remove microscopic particles of cholesterol or cancer, they would also be ready to rebuild individual molecules to create a new tissue layer.

This could be particularly useful for accident victims and others whose tissue has been extensively damaged due to intense injury. In cases where a bone has been broken, scientist have officially made a "nanobone" which has all the properties of natural bone but is also much stronger and more flexible. This invention naturally prompts the possibility of a nanobot going in and repairing shattered or missing bones a little at once. It also presages innovations, for example, nanobots that can rebuild or replace bone marrow, making large steps towards curing leukemia [7].

Nanorobots could perform a variety of similarly miraculous functions, from consuming dead tissue at a wound site (a task which is currently performed by maggots in many cases) to actually re-growing tissue so that it heals cleanly and quickly without leaving a frightful scar. A few patients even have difficulties with festering wounds, which could be effectively cleared up by an efficient medical nanorobot.

Individual with special needs and diseases would be among those to benefit immensely from such remedies; sufferers of hemophilia cannot normally clot well enough to heal and in some cases may even bleed to death when left at the mercy of today's conventional medicine—but a specially-designed team of nanorobots could perhaps produce synthetic clotting material for their wound sites in order to stop the bleeding.

They could also perform delicate surgical functions such as closing a split vein or a gash at the same time. Nobody is truly sure whether this would be more or less painful than traditional surgical methods, yet for sufferers of anesthesia anaphylaxes and those who don't handle surgery well because of issues like hemophilia, it could make a tremendous difference [8].

The development of nanorobots may provide remarkable advances for diagnosis and treatment of tumor. Nanorobots could be an exceptionally supportive and hopeful for the treatment of patients, since current treatments like radiation therapy and chemotherapy often end up destroying more healthy cells than carcinogenic ones. Starting here of perspective, it gives a non-depressed therapy for cancer patients. The Nanorobots will have the capacity to recognize between different cell types that is the malignant and the normal cells by checking their surface antigens (they are different for each type of cell). This is expert by the use of chemotactic sensors keyed to the specific antigens on the target cells. An alternative methodology utilizes the imaginative procedure to achieve decentralized control for a distributed collective action in the combat of cancer. Utilizing chemical sensors they can be customized to detect different levels of Ecadherin and beta-catenin in primary and metastatic stages. Medical nanorobots will then obliterate these cells, and just these cells. The following control methods were considered: h Random: nanorobots moving passively with the fluid reaching the target only if they bump into it due to Brownian movement. h Follow gradient: nanorobots screen concentration intensity for E-cadherin signals, when find out, measure and follow the gradient until coming to the target. If the gradient estimate subsequent to signal detection finds no additional signal in 50ms, the nanorobot considers the signal to be a false positive and continues flowing with the liquid. „h Follow gradient with attractant: as above, but nanorobots touching base at the target, they discharge in addition a different chemical signal used by others to improve their ability to discover the target. In this manner a higher gradient of signal intensity of E-cadherin is used as chemical parameter identification in guiding nanorobots to identify malignant tissues. Integrated nanosensors can be used for such a task in order to find intensity of E-cadherin signals. Thus they can be utilized effectively for treating cancer [9].

APPROACHES OF NANOROBOTS:

Biochip : They are use in of nanoelectronics and new biomaterials provides a possible approach to manufacturing nanorobots for common medical applications, for instance, for surgical instrumentation, analysis and drug delivery[8-10] Biochip are extremely important research tool. Biochip have found many applications in data-mining, significantly parallel genome-wide assays, bioinformatics investigation, sample separation, and monitoring applications however in the field of medical they are used for diagnosis and treatment of diseases. Biochips not just comprise of immobilized bio molecules spatially addressed on planar surfaces, additionally contain bio molecules fixed in micro channels or microcells or on an array of beads or sensors. Nanotechnology has made biochips more relevant for commercialization purpose where biochips could be implanted inside body to dynamically transmit the information and monitor any biological changes in vivo. There has been noteworthy advance on applications of biochips such as DNA chips, protein chips, and carb chips or starch, and in the field of medical nanotechnology [10].

Nubots: Nubot is an abbreviation for "nucleic acid robot. They are organic molecular machines. DNA structure can provide means to assemble 2D and 3D nanomechanical devices. DNA based machines can be incited using small molecules, proteins and other atoms of DNA. Nubots have DNA structure used for targeting drug delivery as a carrier [10].

Positional nanoassembly:

Nanofactory Collaboration, established by Robert Freitas and Ralph Merkle in 2000 and involving 23 researchers from 10 organizations and 4 countries, focuses on developing a, practical research aagenda specifically aimed at developing positionally contro lled diamond mechano synthesis and a diamondoid nanofact ory that would have the capability of building diamondoid medical nanorobots.

Open technology: A document with a proposal on nanobiotech development using open technology approaches has been addressed to the United Nations General Assembly. As indicated by the document sent to the UN, in the same manner that Open Source has in recent years accelerated the development of computer systems, a comparative approach should benefit the society at large and accelerate nanorobotics development.

Bacteria-based: Bacteria-based approaches are used of biological microorganisms, like the bacterium Escherichia coli. Electromagnetic fields normally control the motion of this kind of biological integrated device [1].

Nanorobotics in medical sciences:

- **Treating arteriosclerosis:** Arteriosclerosis refers to a condition where plaque builds along the walls of arteries. Nanorobots could possibly treat the condition by cutting away the plaque, which would then enter the circulatory system. Nanorobots may treat conditions like arteriosclerosis by physically chipping away the plaque along artery walls.
- **Breaking up blood clots:** blood clots can cause complications ranging from muscle death to a stroke. Nanorobots could go to a clot and break it up. This application is a standout amongst the most risky uses for nanorobots. The robots must be able to remove the blockage without losing small pieces in the bloodstream, which could then travel somewhere else in the body and cause more issues. The robot must also be small enough with the goal that it doesn't block the flow of blood itself
- **Fighting cancer:** doctor hope to use nanorobots to treat cancer patients. The robots could either attack tumors straightforwardly using lasers, microwaves or ultrasonic signs or they could be part of a chemotherapy treatment, delivering drug directly to the cancer site. Doctor believe that by delivering small but precise doses of medication to the patient, reactions will be minimized without a loss in the medication`s effectiveness.
- **Helping the body clot:** one particular kind of nanorobots is the clottocyte or manufactured platelet. The clottocyte conveys a small mesh net that dissolve into a sticky membrane upon contact with blood plasma.
- **Parasite removal:** Nanorobots could wage micro-war on bacteria and small parasitic organisms inside a patient. It may take a few nanorobots working together to destroy all the parasites.
- **Gout:** people who suffer from gout experience intense pain at these joints. A nanorobots could brak up the crystalline structure at the joints, giving relief from the symptoms, however, it wouldn't be able to reserve the condition permanently.
- **Breaking up kidney stones:** kidney stones can be strongly painful, the larger the stone the more difficult it is to pass. Doctor break up large kidney stones using ultrasonic frequencies, but it is not continuously effective. A nanorobot could break up a kidney stones using a small laser. Nanorobots might carry small ultrasonic signal generators to deliver frequencies directly to kidney stones.
- **Cleaning wounds:** Nanorobots could help remove debris from wounds, decreasing the probability of infection. They would be specially valuable in cases of puncture wounds, where it may be hard to treat using more conventional methods [11].

Challenges in nanarobotics:

Nanotechnology is still misunderstood by a majority of the public. The reality of matter is that it alludes to a rather broad range of study that can encompass quite a few different disciplines. All in all , nanotechnology is concerned with the creation of microscopic objects. A large number of these objects are so small that they're constructed not with regular materials but with the very atomic building blocks of life [11].

Some of the most basic challenges include:

1. **Powering the nanodevice** – devices at the nanoscale thousands of times smaller than the full stop at the end of this sentence, experience water as a viscous, nectar-like matter (flowing blood or other bodily fluids are even thicker) and require considerable energy consumption to be able to propel and navigate towards a target;
2. **Communication and triggered action** - diagnostic or therapeutic activity by the nanorobot will need to be timed at specific sites in the body and this will require sophisticated and well controlled initiation of activity (preferably wirelessly) that is currently not feasible;
3. **Safety** - irrespective of capability for navigation and activity, any nanodevice intended for administration in patients will need to be toxicologically inert, degradable or ousted from the body.

Doctors today can't affect molecules in one cell while leaving identical molecules in a neighboring cell untouched because medicine today cannot apply surgical control to the molecular level. There are chances to design nanosized, bioresponsive systems ready to diagnose and then convey medication, and systems ready to advance tissue recovery and repair (in disease, trauma and aging), circumventing chemotherapy [12].

Summery and future of nanorobots:

Nanorobot is a nanoscale device these are able to flow through bloodstream, so with the help of this we can cover almost all organs for curing illness. The potential use of such nanodevices can improve the status of human health system. Researchers are taking endeavors to maximize the enormous benefits of this Nanorobot technology by keeping the associated risks at minimum.

All of these current developments in technology direct humans a step closer to nanorobots and simple, working nanorobots is the not so distant in future. It is a bright future that lies ahead for nanomedicine, but we shall all have to work very long and very hard to make it come to pass.

In future, the main emphasis in medicine will shift from medical science to medical engineering, where nanorobotic innovation will be the revolution. This dawn of medical sciences will again expand extremely the effectiveness, comfort and pace of future medical treatments while significantly reducing their danger, cost, and invasiveness.

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