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Nanorobotics: A review

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Abstract
Nanorobotics is the technology of creating machines or robots at or close to the microscopic scale of a nanometer (10-9 meters). More specifically, nanorobotics refers to the still largely hypothetical nanotechnology engineering discipline of designing and building nanorobots, devices ranging in size from 0.1-10 micrometers and constructed of nanoscale or molecular components. Nanorobots will be basically used for the treatement in field of nanomedicine. An intresting utilization of nanorobots may be their attachment to transmigrating inflammatory cells or WBC, to reach inflamed tissues and assist in their healing process. A cream containing nanorobots may be used to cure skin disease. It can be also used for early diagnosis and targeted drug delivery for cancer biomedical instrumentation, surgery, pharmacokinetics, monitoring of diabetes, and health care. The devices could provide an effective long-term drug-free symptomatic treatment for asthma. The nanorobots can be used to prevent most heart attacks. Thus 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); nanorobots are also candidates for industrial applications. They will provide personalised treatments with improved efficacy and reduced side effects that are not available today.

Keywords: nanorobots, nanorobotic structure, nanorobotic design, drug delivery system, anti-cancer treatment

Introduction

Nanorobotics is the technology of creating machines or robots at or close to the scale of a nanometre (10-9 metres), machines constructed at the molecular level (nanomachines) may be used to cure the human body of its various ills. This application of nanotechnology to the field of medicine is commonly called as nanomedicine. Nanotechnology promises futuristic applications such as microscopic robots that assemble other machines or travel inside the body to deliver drugs or do microsurgery. Taking inspiration from the biological motors of living cells, chemists are learning how to utilize protein dynamics to power micro size and nanosize machines with catalytic reactions.

Nanorobotics toolkit contains features like medicine cavity containing medicine, probes, knives and chisels to remove blockages and plaque, microwave emitters and ultrasonic signal generators to destroy cancerous cells, two electrodes generating an electric current, heating the cell up until it dies, powerful lasers could burn away harmful material like arterial plaque. To cure skin diseases, a cream containing nanorobots may be used which remove the right amount of dead skin, remove excess oils, add missing oils, apply the right amounts of natural moisturising compounds, and even achieve the elusive goal of 'deep pore cleaning'. Other fields of applications are to clean the wounds, to break the kidney stones, to treat gout, for parasite removal, for cancer treatment, treatment of arteriosclerosis. Due to the advances in the field of nanotechnology, nanodevice manufacturing has been growing gradually.

From such achievements in nanotechnology, and recent results in biotechnology and genetics, the first operating biological nanorobots are expected to appear in the coming 5 years, and more complex diamondoid based nanorobots will become available in about 10 years. In terms of time it means a very near better future with significant improvements in medicine. In future decades the principal focus in medicine will shift from medical science to medical engineering, where the design of medically active microscopic machines will be the consequent result of techniques provided from human molecular structural knowledge. Nanorobots are theoretical microscopic devices measured on the scale of nanometers (1nm= one millionth of 1 millimeter). Since nanorobots would be microscopic in size, it would probably be necessary for very large numbers of them to work together to perform microscopic and macroscopic tasks.

Nanomedicines nanorobots are so tiny that they can easily traverse the human body. Scientists report the exterior of a nanorobot will likely be constructed of carbon atoms in a diamondoid structure because of its inert properties and strength. Super-smooth surfaces will lessen the likelihood of triggering the body's immune system. Glucose or natural body sugars and oxygen might be a source for propulsion and the nanorobot will have other biochemical or molecular parts depending on its task. A navigational network may be installed in the body, with station keeping navigational elements providing high positional accuracy to all passing nanorobots that interrogate them, wanting to know their location. This will enable the physician to keep track of the various devices in the body. These nanorobots will be able to distinguish between different cell types by checking their surface antigen.

Nanorobotics are an emerging technology field creating machines or robots whose components are at or near the scale of a nanometer These nanorobot swarms, both those which are incapable of replication (as in utility fog) and those which are capable of unconstrained replication in the natural environment (as in grey goo and its less common variants), are found in many science fiction stories, such as the borgnano-probs in star trek. The word “nanobut” (also “nanite”, “nanogene” or “nanoant”) is often used to indicate this fictional content & is an informal or even pejorative term to refer to the engineering concept of nanorobots.

Some components of nanorobotics, in reaction to the grey goo scare scenarios that they earlier helped to propagate, hold the view that nanorobots capable of replication outside of a restricted factory environment do not form a necessary part of a purported productive nanotechnology, and the process of self-replication, if it were ever to be developed, could be made inherently safe. The use of nanorobots for in-vivo monitoring chemical parameters should significantly increase fast strategic decisions. Thus, a nanorobot for medical defense means an effective way to avoid an aggressive pandemic disease to spread into an outbreak. As a direct impact, it should also help public health sectors to save lives & decrease high medical costs, enabling a real time quarantine action.

Elements of Nanorobots

Carbon will likely be the principal element comprising the bulk of a medical nanorobot probably in the form of diamond ordiamondoid/ fullerene nanocomposites, because of the strength and chemical inertness of these forms. Many other light elements such as oxygen &nitrogen can be used for special purposes. The typical size of a blood born medical nanorobot will be 0.5-3 micrometers as it is the maximum size that can be permitted due to capillary passage requirement. These nanorobots would be fabricated in desktop nanofactories specialized for this purpose.

Approaches

Biochip

The joint use of nanoelectronics, photography & new biomaterials can be considered as a possible way to enable the required manufacturing technology towards nanorobots for common medical applications, such as for surgical instrumentation, diagnosis & drug delivery.1-3 This method for manufacturing on nanotechnology sale is currently in use in the electronics industry.1So, practical nanorobots should be integrated as nanoelectronicsshould be integrated as nanoelectronics devices, which will allowtele-operation & advanced capabilities for medical instrumentation.

Nubots

Nubot is an abbreviation for “nucleic acid robot”. Nubots are organic molecular machines at the nanoscale. Biological circuit gates based on DNA materials have been engineered as molecular machines to allow in-vitro drug delivery for targeted health problems.

Positional Nanoassembly Nanofactory collaboration[5] founded by Robert Freitas & Ralph Werkle in 2000, is a focused ongoing effort involving 23 researchers from 10 organizations & 4 countries that is developing positionally-controlled diamondmechanosynthesis & a diamondoidnano factory that would have the capability of building diamondoid medical nanorobots.

Nanorobots/Nanobots

Eric Dexler in 1986 was already talking about creating machines built atom by atom. [7]Currently, it is expected that nanorobots are the future of technology, health and the environment. [8]The applications of nanorobots are many. Nanorobots are tiny machines that can work as today's machines, but more exactly, the development of this new technology, brings benefits in medicine, industry, and others areas [1]. They can be applied to solve problems of energy conversion, using catalytic nanomotors, recent studies search the ability to increase the velocity, force, lifetime, of synthetic nanomotors, some nanomotors are able to move, autonomously at speeds approaching 100 body lengths per second. The improving of velocity, motion control and the lifetime of catalytic nanomotors is very important to create power in chip microsystems powered by autonomous transports. Besides, it is possible to apply this new technology to create a laboratory on a chip device [9].

Another application is to solve infertility problems. German engineers built a nanorobot that connects to the scourge of sperm and acts as an engine by boosting the research aims to make it more accessible and effective fertility treatments [10]. Problems as pollution can also be solved with nanorobots, engineers at the University of California, for instance, are using nanorobots to capture the excess carbon dioxide in the waters of lakes, rivers and even oceans [11]

Structure and Design of Nanorobots

Two types of nanorobots are most widely researched, organic and inorganic. The organic nanorobots, also called bionanorobots, are manufactured using viruses and bacteria DNA cells. Such nanorobot is less toxic to the organism. Inorganic nanobots are created diamond structures [12], synthesized proteins [13] and others types of material. These types of robots are more toxic, a way of reducing this problem is to encapsulate the robot, this method also avoids its destruction by the body’s defense system, this problem, has been a major challenge faced by researchers [14]. With knowledge about biological motors of living cells, scientists can learn how to power micro sized and nano-sized machines with catalytic reactions [15].

A team of South Korean scientists, of Chonnam National University, has developed organic nanorobots made with the salmonella bacteria genetically modified in order to not show toxicity, this nanorobot is attracted to molecules released by cancer cells and was named Bacteriobot, with about three micrometers. When they reach the cancer cells, they release the drug, the Bacteriobot were designed to attack colorectal tumors and achieved satisfactory results in tests with laboratory rats [16]. At Rice University, Texas, United States, a team has created nanomachines that resemble nanocars. The molecules have the basic mechanics of a car: wheels, made with carbon 60, chassis, comprising planar molecules and axes connecting the wheels to the chassis by triple bonds of carbon, these nanocars are able to move over a surface when supplied [16]. Another study, at the Chemistry Institute of the Federal Fluminense University, has developed a nanovalve, formed by a reservoir closed by a door, where dye molecules are stored, they can move out in a controlled manner when the door open. This deviceis also organic, composed of silica (SiO2), beta-cyclodextrins and organometalic molecules, such nanovalves can be applied in Drug Delivery Systems [17].

Some research uses proteins, to feed nanomotors that can move large objects, DNA hybridization, antibody protein also is used in the construction of nanorobots. Different types of chemical substances can be employed to functionalize a nanorobot [10]. Some nanorobots are made of liquid crystal elastomers and are light-activated, presenting advantage is due to an ease internal engine and propulsion, as the one developed by researchers at the Max Planck Institute in Germany that has been made to mimic protozoa, and its composition is such that the body is is green light self-propelled. One type of inorganic nanorobot was made with an array of tiny planar coils generating fields, these fields create magnetic blocks, representing a possible position for the nanorobot, and they also possess magnetic disk and a lower surface which allows sliding the positions that can be take. The prototype is about two millimeters in diameter, but the researchers plan to improve the design to further decrease the nanorobot size to about 250 micrometers in diameter.

Nanorobotics and DDS

Predictions about the use of nanorobotics considered applications in Central Nervous System (CNS), cancer treatment, body surveillance, delicate surgeries, endoscopy, among others. Challenges such as limitations of nanotechnology and few studies focused on the fundamental understanding of behavior in the nanoworld, difficult handling and construction of these nanomachines. In nanomedicine, it has been explored in DDS, which act directly on target points of the human body. Researchers develop systems able to deliver drugs in specific locations also controlling up the dosage and frequency of this release. Drug Delivery Systems can be applied in the treatment of articular diseases, dental, diabetes, cancer and other

Diseases such neoplasms, hepatitis, diabetes, pulmonary, dentistry and cancer can be used nanorobotics technology as a means of implementing the DDS. One of the advantages of this technology is the diagnosis and treatment of the diseases with minimum prejudice to the healthy cells lowering the risk of unfavorable effect, directing healing and reconstructive treatment at the cellular and subcellular stances.

Technology Applied in Nanorobotics for Use as DDS

Recent improvements in drug delivery turns up higher quality in targeted drug delivery that identify the specific cells with the self of nanosensors and regulate the discharge by use of smart drugs. Some researchers classify nanorobots in drug delivery and therapeutics according to the their applications, which are described below:

Pharmacyte Classified as medical nanorobots size of 1-2 µm able to carrying up 1 µm 3 a given drug in the tanks. They are controlled using mechanical systems for sorting pumps. Depending on the situation the weight is discharged in the extracellular fluid or cytosol (the aqueous component of the cytoplasm of a cell). They are provided with a molecular markers or chemo Nanorobotics in Drug Delivery Systems for Treatment of Cancer: A Review 171 tactic sensors that guarantees full targeting accuracy. Glucose and oxygen extracted from the local environments such as blood, intestinal fluid and cytosol are the onboard power supply. After the nanorobot completing tasks they can be removed or recovered by centrifuge nanapheresis.

Diagnosis and Imaging: The authors cite microchips that are overlaid with human molecules. The chip is projected to send an electrical signal when the molecules detect a disease. Gives an example of special sensor nanobots that can be introduced into the blood under the skin where they verify blood contents and notify of any possible diseases. They can also be used to monitor the sugar level in the blood. Advantages are the low price to produce and easily to manipulate Respirocytes: It's about an artificial red blood cell which is a blood-borne spherical 1 µm diamondoid 1,000-atmosphere pressure vessel with reversible molecule-selective pumps. The power is obtained by endogenous serum glucose. This artificial cell is able to give 236 times more oxygen to the tissues per unit volume than RBCs (Red blood cells) and to administer acidity. The nanomachine is constructed with 18 billion atoms justly organized in a diamondoid pressure tank that is pumped full of up to 3 billion oxygen (O2) and carbon dioxide (CO2) molecules. It is possible to release these gasses from the tank. Gas concentration sensors on the outside will signal when it is time to discharge O2 and unload CO2.

Clottocytes

This nan-orobot is classified with a unique biological capability: "instant" hemostasis using clottocytes, or artificial mechanical platelets. It is known that platelets are roughly spheroidal nucleus-free blood cells measuring approximately 2 µm in diameter. Platelets join at a place of bleeding. There they are activated, becoming tacky and lumping together to form a tampon that aid stamp the blood vessel and stop the bleeding. They also delivery substances that help promote coagulating. Another interesting feature is its ability to perform phagocytosis of foreign particles and killing of microfilarial larval parasites. A complete functional design is elaborate but the work of Freitas (2016) focus on the purely mechanical aspects of the hemostatic function of platelets, and report the function in a small *in vivo* population of medical nanorobotic devices.

Microbivores

It is an oblate spheroidal device for nanomedical applications with 3.4 µm in diameter along its major axis and 2.0 µm in diameter along its minor axis. Composed precisely organized by 610 billion atoms in a 12.1 µm 3 geometric volume. The nanobot can continually consume up to 200 pW. This power is used for digest trapped microbes. Microbivores have different characteristics of natural or antibiotic-assisted biological phagocytic defenses, acting as approximately up to 1,000 times faster. Another distinctive feature is related to the ability to phagocyte approximately 80 times more efficiently than macrophages agents, in terms of volume/sec digested per unit volume of phagocytic agent.

Thus, according to the existing technological proposals, nanorobots are an efficient and innovative way for applications in nanomedicine, including DDS and theranostic (diagnostic and therapeutic). Searching keywords "drug delivery systems" in database Periódicos CAPES, it was obtained 176, 511 publications. Only 0.21% is related to nanorobotics, and this amount of work only 8% have the relationship "drug delivery systems and nanorobotics".

Another database searched was Web of Science. The results were 113,896 publications with the keyword "drug delivery" and 201 for nanorobotics. The survey also showed that only 0.02% was published with the correlation "drug delivery and nanorobotics". Before the number of published papers, it is noted that much more should be done so that nanomedicine can grow apace with the help of nanorobotics in treating diseases, in particular cancer.

Drug Delivery Systems for Anticancer Drugs

The therapeutic index of most anticancer drugs is narrow, causing toxicity to normal stem cells, hematological adverse effects, gastrointestinal among other. Doxorubicin is used in several types of cancer, such as HD (Hodgkin's disease), in which treatment is administered in combination with other anti-neoplastic agents in order to reduce their toxicity. The Paclitaxel is administered by intravenous infusion and plays a role in the treatment of breast cancer. Among the adverse effects encountered some serious, are bone marrow suppression and cumulative neurotoxicity.

Cisplatin is an alkylating agent which causes intra DNA binding filaments. Some of its side effects are nausea and severe vomiting as well as can be nephrotoxic. Camptothecin is used in the treatment of neoplasias due to inhibition of type I topoisomerases, an essential enzyme for cellular replication genetic material. Several efforts have been implemented with the intention of using nanotechnology to develop DDS that can minimize the harmful effects of conventional therapies. Clinical trials are studies in humans to measure the parameters of safety and efficacy of new drugs, it is essential for the arrival of new therapeutic alternatives in the market.

Anyway, just a few Drug Delivery Systems reached more advanced stages of clinical evaluation such as basically consisting of doxorubicin, paclitaxel, camptothecin and platinum complexes Anyway just a few DDS reached more advanced stages of clinical evaluation such as basically consisting of doxorubicin, paclitaxel, camptothecin and platinum complexes. Doxorubicin was stacked on the surface of Single-Walled Carbon Nanotubes (SWNTs).

The Doxorubicin was employed as polymer prodrug/collagen hybrid in metastatic tumor cells. The use of a polymeric prodrug nanotechnology applied to the treatment of neoplasia shows up as a new development in this area boundary. Superparamagnetic Nanoparticles of Iron Oxide (SPIONs) loaded with doxorubicin were coated with modified inulin and evaluated when the potential use in antineoplastic therapy. The search for biocompatible materials and can serve as a Drug Delivery System is always the focus of nanotechnology.

Nanoparticle HA (Hydroxyapatite) - a major constituent of bone and teeth - were used to carry Paclitaxel (Tax), an antineoplastic agent - and the results suggest good expectation with treatment starting from hydrophobic drugs. Searching carbon materials nanoscalegraphene oxide was tested as a drug carrier of anti-cancer. Another possible application area of the drug delivery system is especially important in the intrathecal route of administration for the relief of pain related to certain types of cancer.

The application Drug Delivery System Intrathecal may be useful in refractory pain to other of administration or even in cases of persistent pain. Again, observing the research with the themes "Drug delivery Systems and Cancer" found a total of 31134 publications. As noted in recent years, the interest increase the DDS is directly associated with the need for alternative conventional chemotherapeutics which possess some serious side effects to the patient.

Limitations of Chemotherapy

The Conventional chemotherapeutic agents work by destroying rapidly dividing cells, which is the main property of neoplastic cells. This is why chemotherapy also damages normal healthy cells that divide rapidly such as cells in the bone marrow, macrophages, digestive tract, and hair follicles. The conventional chemotherapy is that it cannot give selective action only to the cancerous cells. This results in common side effects of most chemotherapeutic agents which include myelosuppression (decreased the production of white blood cells causing immunosuppression), mucositis (inflammation of the lining of the digestive tract), alopecia (hair loss), organ dysfunction, and even anemia or thrombocytopenia. These side effects sometimes impose dose reduction, treatment delay, or discontinuance of the given therapy. Furthermore, chemotherapeutic agents often cannot penetrate and reach the core of solid tumors, failing to kill the cancerous cells.

Traditional chemotherapeutic agents often get washed out from the circulation being engulfed by macrophages. Thus they remain in the circulation for a very short time and cannot interact with the cancerous cells making the chemotherapy completely ineffective. The poor solubility of the drugs is also a major problem in conventional chemotherapy making them unable to penetrate the biological membranes. Another problem is associated with P-glycoprotein, a multidrug resistance protein that is over expressed on the surface of the cancerous cells, which prevents drug accumulation inside the tumor, acting as the efflux pump, and often mediates the development of resistance to anticancer drugs. Thus the administered drugs remain unsuccessful or cannot bring the desired output.

Nanorobots in Cancer Treatment

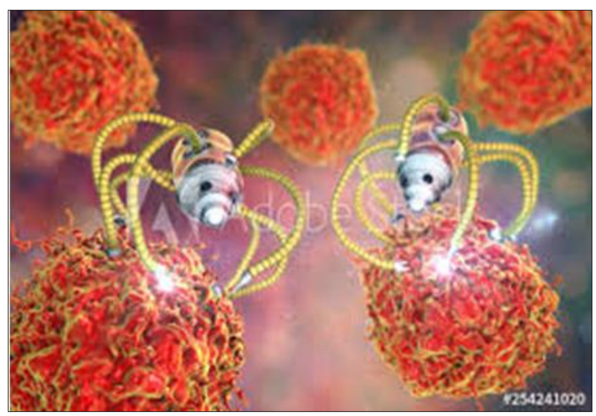

Fig 1: Nanorobots used in cancer treatment

Cancer could be defined as the group of diseases characterized by the uncontrolled growth and spread of abnormal cells in the body is what defines cancer, and the number of individuals affected each year continues to climb. Cancer takes the first place in the research due to its effect of human life and its cost to the economy. Conforming to the Global Oncology Trend Report, by the IMS Institute for Healthcare Informatics, global spending on cancer medications has reached to $100 billion in 2014 [4].

Cancer treatment is probably the main reason for the development of nanorobotics, it can be successfully treated with current stages of medical technologies and therapy tools with the help of the nanorobotics. For determine the prognosis and chances for a patient with cancer to survive it could be consider: time of disease evolution considering the diagnosis time if earlier have better prognosis; another important aspect to achieve a successful treatment for patients isthe development of efficiently targeted drug delivery to decrease the side effects of chemotherapy.

Considering the properties of nanorobots to navigate as blood borne devices, they can help important treatment processes of complex diseases in early diagnosis and smart drug delivery. A nanorobot can provide an efficient early diagnosis of cancer and help with smart chemotherapy for drug delivery. Nanorobots as drug carriers for timely dosage regimens allows maintaining the chemical compounds for a longer time as necesscirculation, providing predicted pharmacokinetic parameters for chemotherapy in anti-cancer treatments. It avoids the current resulting extravasations towards nonreticuloendothelial-located cancers with the high degenerative side-effects during the chemotherapeutic process. Nanorobots with chemical nanobiosensors can be programmed to detect different levels of E-cadherin and beta-catenin as medical targets in primary and metastatic phases, helping target identification and drug delivery. 3.8 Drug Delivery and Nanorobots in Cancer Treatment The clinical use of nanorobots for diagnosis, therapeutic and surgical purposes should be done with intravenous injection. Therefore, the nanorobots can be released directly into the patient's bloodstream ary into the bloodstream.

Themajor cancer treatment cycle for chemotherapy pharmacokinetics includes absorption and metabolism, plus a break for the body's re-establishment before the next chemotherapy session. Patients are normally treated in cycles of every 2 weeks for small tumors. As an initial time threshold for medical purpose, nanorobots should be able to analyze and provide a body diagnosis within one week through the use of proteomic-based sensors. The uptake kinetics of a low molecular weight using a magnetic resonance contrast agent can predict the delivery of protein drugs to solid tumors. Hence, a similar approach is useful to verify *in vivo* nanorobot's biosensor activation through targeted antigen detection. The test and diagnosis is an important part of the research on nanorobotics. It enables rapid testing diagnosis at first visit so without the need of follow-up visit after the lab test, and detection of diseases at an earlier stage. The limitation in *in vivo* use of nanorobot is the need of energy for propulsion. Higher levels of energy are required since "low inertia and high viscous forces are coupled with low efficiency and low convective motion". The fuels of chemically powered nanomotors were toxic. The availability of alternative sources of energy such as sound waves and light has led an increase in the research of *in vivo* use of nanorobots where resulted in more patent applications. One study of nanomotors is the "Acoustic Propulsion of Nanorod Motors inside Living Cells" which was a result of the development of ultrasonic-wave powered minerals, which are safe for living systems.

Gao *et al*. reported an *in vivo* model of artificial micromotors in a living organism. The model examines the distribution, retention, cargo delivery, and acute toxicity role of synthetic motors in mouse stomach via oral administration. This work is anticipated to significantly advance the emerging field of nano/micromotors and to open the door to *in vivo* evaluation and clinical applications of these synthetic motors". This development may be an important step for the possibility of *in vivo* applications of the drug delivery for the cancer treatment with decreasing the side effects of chemotherapy.

A CMOS (Complementary metal oxide semiconductor) for constructing circuits with feature sizes in the tens of nanometers as a hybrid biosensor with single-chain antigen-binding proteins. This process uses activation based on proteomics and bioelectronics signals for medicament release. Therefore, each time the nanorobot detects predefined changes of protein gradients, nanoactuators are activated to manipulate drug delivery. Changes to chemical and thermal signals are applicable conditions directly related to major medical target identification. Some examples of Nanorobotics in Drug Delivery Systems for Treatment of Cancer: A Review 175 changing protein concentrations inside the body near a medical target under pathological circumstances are NOS (Nitric oxide synthase), E-cadherin and Bcl-2. Moreover, a change of temperature normally occurs for inflamed tissues. The model incorporates chemical and thermal parameters as clinically and therapeutically the most important guidelines on nanorobot prototyping analysis.

Nanorobotics in Drug Delivery Systems for Treatment of Cancer: A Review 176 difficulty of achieving tangible results. Also demonstrates the need for greater investment to conduct research in the area. However, it is observed that the evolution of nanotechnology possibly triggers an accelerated development of all research related to nanoworld, including rapid insertion of nanorobots in conventional medicine.

Bacteria Based

This approach proposes the use of biological microorganisms, like E. coli bacteria. Thus the model uses a flagellum for propulsion purposes. The uses of electromagnetic fields are normally applied to control the motion of this kind of biological integrated device. Molecular machines Nanorobots need energy to carry out different manipulations such as propulsion, force, actuation, communication or any other activity in the biological system at nano-scale [8]. This energy can be generated by natural (biological) or artificial (chemical) entities known as molecular motors, which when perform at nano-scale are known as Nanomachines [9].

Applications

Molecular machines Nanorobots need energy to carry out different manipulations such as propulsion, force, actuation, communication or any other activity in the biological system at nano-scale [8]. This energy can be generated by natural (biological) or artificial (chemical) entities known as molecular motors, which when perform at nano-scale are known as Nanomachines [9]. The natural molecular motors are present in a biological system and carry out important functions in the body at molecular or nano level. Most of these motors are composed of proteins or DNA. Scientists are studying these natural motors elaborately in order to use them as efficient and reliable motors for artificial nanorobots, e.g., Kinesin molecular motors [10], flagella motors [11], DNA Scissors [12] and DNA Tweezers [13, 14]. Similarly, chemical molecular motors are also being used as nanomachines in artificial nanorobotics [15]. These machines are difficult to synthesize but are more robust than natural machines. Mostly, these machines are constructed from organic compounds such as Carbon, Nitrogen, and Hydrogen and can be controlled chemically, electrochemically or photochemically. Many chemical molecular machines are constructed using interlocked organic compounds known as Rotaxanes and Catananes [16].

Nanofabrication and assembly currently, scientists have succeeded to develop only biological nanorobotic systems, whereas, artificial nanorobots are still a concept that is being explored aggressively. The key challenge in the development of these systems is their fabrication and assembly at nano-scale.

Self-assembly of nanostructures is emerging as another useful method [17].

Several other hypothetical nanorobotic systems have been proposed for the treatment Applications.

Applications of nanorobots are expected to provide remarkable possibilities:

a. An interesting utilization of nanorobots may be their attachment to transmigrating inflamatory cells or white blood cells, to reach inflamed tissues & assist in their healing process [3].
b. Potential applications for nanorobotics in medicine include early diagnosis & targeted drug-delivery for cancer 6, 7, 8, biomedical instrumentation 9 surgery 10, 11 pharmacokinetics 12 monitoring of diabetes 13, 14, 15 & health care.
c. They can process specific chemical reactions in the human body as an auxiliary device for injured organs.
d. Nanorobots will be applied in chemotherapy to combat cancer through precise chemical dosage administration & a similar approach could be taken to enable nanorobots to deliver anti-HIV drugs. Such drug- deliverynanorobots have been termed "pharmacytes" [16].
e. Nanorobots equipped with nanosensors could be used to detect glucose demand in diabetes patients.
f. They are capable of locating atherosclerotic lesions in stenosed blood vessels, particularly in the coronary circulation& treat them either mechanically, chemically or pharmacologically [16]
g. To cure skin diseases a cream containing nanorobot may be used. It could remove the right amount of dead skin, remove excess oils, add missing oils, apply the right amount of natural moisturizing compound & even achieve the elusive goal of deep pore cleaning by actually reaching down into pore & cleaning them out. The cream could be a smart material with smooth-onped-off convenience [17]
h. Surgical nanorobots could be introduced into the body through the vascular system or at the ends of catheters into various vessels & other cavities in the human body. A surgicalnanorobot, programmed or guided by a human surgeon, could act as a semi-autonomous on site surgeon, inside the human body.

Conclusion

Nanorobots provide the field of medicine promising hopes for assistance in diagnosis and treatment. Humans have the potential to live healthier lives in the near future due to the innovations of Nanorobots. As further research continues in this field more treatments will be discovered and many diseases that do not have cures today may be cured by nanotechnology in the future. Nanorobotics is an upcoming field of medical science which diagnose and treats cancer and diabetes with remarkable applications in health care. In future, nanorobots will be useful or applicable in treating various diseases like cancer, diabetes, tumour or respiration related diseases.

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