wjpls, 2019, Vol. 5, Issue 6, 118-132 *Review Article* ISSN 2454-2229

World Journal of Pharmaceutical and Life Sciences
WJPLS
www.wjpls.org
SJIF Impact Factor: 5.088

NANOBAOTS: ANOVERVIEW

Jesika Rane*, Uttkarsha Patil, Nishikant Patil, Pravin Pawar and Dr. V. R. Patil

Department of Quality Assurance, Tves. College of Pharmacy, Faizpur.

***Corresponding Author: Jesika Rane**
Department of Quality Assurance, Tves. College of Pharmacy, Faizpur.

Article Received on 19/07/2019 **Article Revised on 07/08/2019** **Article Accepted on 28/08/2019**

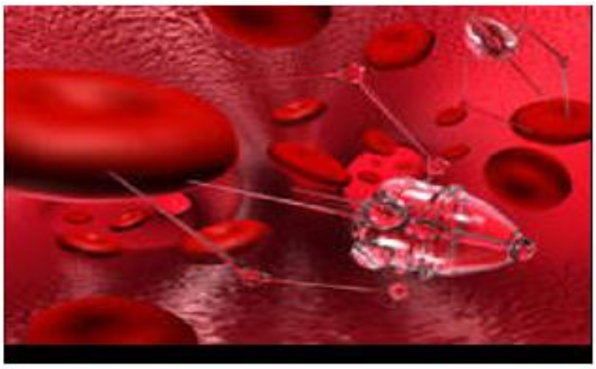
ABSTRACT

Nanobotics are an emerging technology field creating machines or robots whose components are at or near the scale of nanometer (9-10 meters). Nanobots are incredibly tiny robots, down at macroscopic scale. The name comes from a combination of nanometer which is 1 billion of meter. Nanobots are so tiny that they can easily transfer in the human body. Nanobots will typically be 0.5-3 microns large with 1-100 nm parts.[1] The exterior of nanobots will likely be constructed of carbon atom in diamondoid structure because of its inert properties and strength. Once infected or dammaged tissue is identified and then multiple programme medical nanobots are introduced inside the infected patient body and nanobots automatically detect infected or damaged tissue, all the nanobots moves to the infected tissue and use laser to remove infected or dead cells attached to the infected tissue. once All the dead cells are removed and infected area is cleaned by nanochemical then nanobot start repairing the tissues. The major components of nanobots are molecular sorting rotor, propeller, nanocamera, fin. Nanobots are used in surgery, diagnosis and testing, in gene therapy, in detection and treatment of cancer, breaking kidney stone and breaking clots in blood. The currently available drugs can increases the patient life, so innovation of nanobots will make the patient to get rid of the disease. They do not generate any harmful activities. But the disadvantages of nanobots are they are high cost, complicated. Nanobots are only field that as the capability of doing things in invisiblerange.

KEYWORDS: nanoboats, shape, applications of nanoboats.

INTRODUCTION

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.[1] As artificial non biological nanorobots have yet been created, they remain a hypothetical concept. The names nanobots, nanoids, nanites or nanomites have also been used to describe these hypothetical devices. Another definition is a robot that allows precision interactions with nanoscale objects, or can manipulate with nanoscale resolution. Following this definition even a large apparatus such as an atomic force microscope can be considered a nanorobotic instrument when configured to perform nanomanipulation. Also, macroscale robots or microrobots that can move with nanoscale precision can also be considerednanorobots.[2]



The first useful applications of nanomachines, if such are ever built, might be in medical technology, where they might be used to identify cancer cells and destroy them. Another potential application is the detection of toxic chemicals, and the measurement of their concentrations, in the environment. Recently, Rice University has demonstrated a single molecule car developed by a chemical process and includes buckyballs for wheels.[10] It is actuated by controlling the environmental temperature and by positioning a scanning tunneling microscope tip. 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. Nanotechnology promises futuristic applications such as microscopic robots that assemble other machines or travel inside the body to deliver drugs or do microsurgery. These machines will face some unique physics. Nanorobots are nanodevices that will be used for the purpose of maintaining and protecting the human body against pathogens. They will have a diameter of about 0.5 to 3 microns and will be constructed out of parts with dimensions in the range of 1 to 100 nanometers. The main element used will be carbon in the form of diamond / fullerene nanocomposites because of the strength and chemical inertness of these forms.[1]

History

- It was first propose by Richard Feynman in 1959. According to Richard Feynman, it was his former graduate student and collaborator Albert Hibbs who originally suggested to him the idea of a medical use for Feynman's therotical micromachines.[9]
- In the 1980's, Eric Drexler elaborated this concept in his popular book Engines of creations.[12]
- Over the years, nanotechnology researcher Robert Freitas has built up an impressive and detailed body of work on how to build real, working nanobots for medical and human enhancement purposes.[15]

Types of Nanobots

There are 7 types of nanobots which are given below:

- **Chromallocytes Respirocytes**
- Microbevores
- Clottocytes

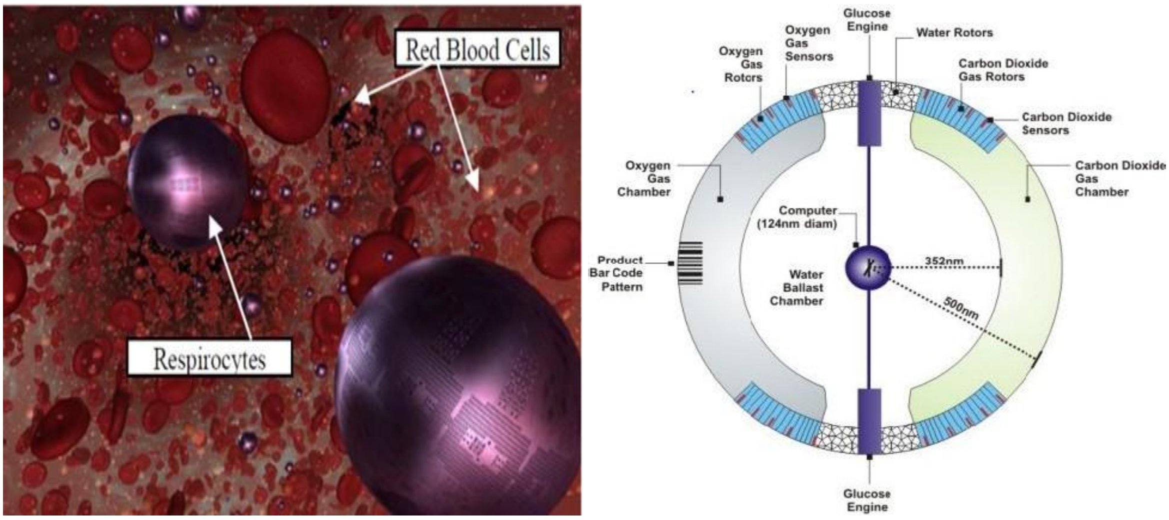
- **Cellular repair nanobots**
- Pharmacytes
- Dentifrobots

Table No. 1: Different Hypothetical Nanobotics System.

System	Application	references
Microbivores	Artificial mechanical white cells	(5)
Respirocytes	Artificial mechanical red cells	(5)
Dentifrobots	Dental nanorobots	(5)
Clottocytes	Artificial mechanical platelets	(6)
Pharmacytes	Nanorobotic pharmaceutical drug delivery device	(7)
Chromallocytes	Gene delivery, chromosome replacement therapy (CRT)	(8)

(1) Respirocytes

Respirocytes are the nanorobots designed as artificial mechanical red blood cells which are blood borne spherical 1 µm diameter sized. The outer shell is made of diamondoid 1000 atm pressure vessel with reversible molecule-selective pumps. Respirocytes carry oxygen and carbon dioxide molecules throughout the body.[5] The respirocyte is constructed of 18 billion atoms which are precisely arranged in a diamondoid pressure tanks that can store up to 3 billion oxygen and carbon dioxide molecules. The respirocyte would deliver 236 times more oxygen to the body tissues when compared to natural red blood cells. The respirocyte could manage the carbonic acidity which will be controlled by gas concentration sensors and an onboard nanocomputer.[1] The stored gases are released from the tank in a controlled manner through molecular pumps. The respirocytes exchange gasesmolecular rotors. The rotors have special tips for particular type of molecule.[1]



Struture of respirocytes

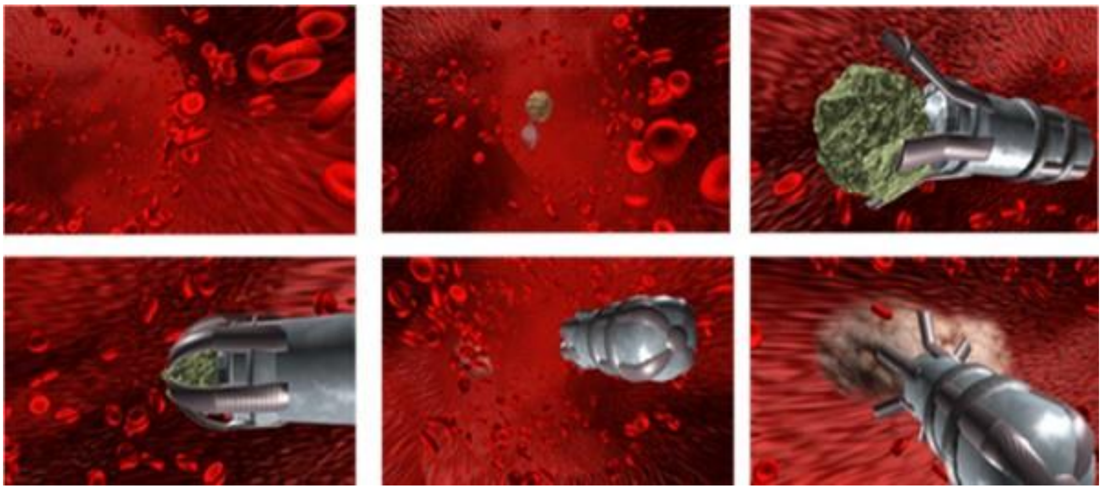
Each respirocyte consists of 3 types of rotors. One rotor releases the stored oxygen while travelling through the body. The second type of rotor captures all the carbon dioxide in the blood stream and release at the lungs while the third rotor takes in the glucose from blood stream as fuel source. There are 12 identical pumps which are laid around the equator; oxygen rotors on the left, water rotors in the middle and carbon dioxide rotors in the left. There are gas concentration sensors on the surface of respirocyte. When the respirocyte passes through the lung capillaries, O2 partial pressure will be high and CO2 partial pressure will be low, therefore the onboard nanocomputer commands the sorting rotors to load in oxygen and release the carbon dioxide molecules. The water ballast chambers aid in maintaining buoyancy. The respirocytes can be programmed to scavenge carbon monoxide and other poisonous gases from the body.[5]

2) Microbivores

Microbivores are the nanorobot which functions as artificial white blood cell and also known as nanorobotic phagocytes. The microbivore is a spheroid device made up of diamond and sapphire which measures 3.4 µm in pathogens present in the blood stream and break down to smaller molecules. The main function of microbivore is to absorb and digest the pathogens diameter along its major axis and 2.0 µm diameter along minor axis and consists of 610 billion precisely arranged structural atoms. It traps in the in the blood stream by the process of phagocytosis.[5] The microbivore consist of 4 fundamental components:

i. An array of reversible binding sites.
ii. An array of telescoping grapples.
iii. A morcellation chamber.
iv. Digestion chamber.

During the cycle of operation, the target bacterium binds to the microbivore surface via species-specific reversible binding site. A collision between the bacterium and the microbivore brings in the surface into intimate contact, allowing the reversible binding site to recognize and weakly bind to the bacterium. A set of 9 different antigenic markers should be specific and confirm the positive binding event confirming the presence target microbe. There would be 20,000 copies of the marker sets distributed in 275 disk shaped regions across microbivore.[5] When the bacterium is bound to the binding site, the telescopic robotic grapples rise up from the surface and attach to the trapped bacterium thereby establishing a secure anchorage. The grapple's handoff motion can transport the bacterium from binding site to the ingestion port. Further the bacterium is internalized into the morcellation chamber where in the bacterium is minced into nanoscale pieces. The remains are pistoned into the digestion chamber which consists of a pre-programmed set of digestive enzymes. These enzymes are injected and extracted 6 times during a single digestion cycle, where in the morcellate is progressively reduced into amino acids, mononucleotides, free fatty acid and simple sugars. These small molecules are then discharged into the blood stream through the exhaust port. After the destruction of pathogens the microbivores exits the body through the kidneys and are then excreted in urine.[4]

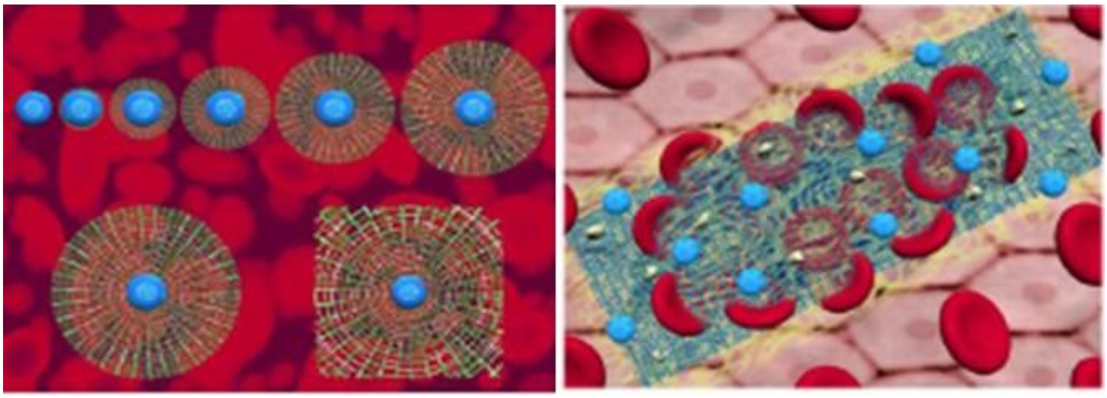


Images of microbivores.

An entire cycle of phagocytosis by microbivore will be completed in 30 seconds. There are no chances of septic shock or sepsis as the bacterial components are internalized and digested into non-antigenic biomolecules. The microbivore is 1000 times faster acting than antibiotic aided white blood cells and the pathogen stand no chance of multiple drug resistance. They can also be used to clear respiratory, cerebrospinal bacterial infection or infections in urinary fluids and synovial fluids.[5]

3) Clottocytes

Hemostasis is the process of blood clotting when there is damage to the endothelium cells of blood vessels by platelets. These platelets can be activated by collision of exposed collagen from damaged blood vessels to the platelets. The whole process of natural blood clotting can take 2-5 minutes. The nanotechnology has shown the capabilities of reducing the clotting time and reducing the blood loss. In certain patients, the blood clots are found to occur irregularly. This abnormality is treated using drugs such corticosteroids.[6] The treatment with corticosteroids is associated with side effects such as hormonal secretions; blood/platelet could damage lungs and allergic reactions. The theoretically designed clottocyte describes artificial mechanical platelet or clottocyte that would complete hemostasis in approximately 1 sec. It is spherical nanorobot powered by serum-oxyglucose approximately 2 µm in diameter containing a fiber mesh that is compactly folded onboard. The response time of clottocyte is 100-1000 times faster than the natural hemostatic system.[6] The fiber mesh would be biodegradable and upon release, a soluble film coating of the mesh would dissolve in contact with the plasma to expose sticky mesh.Reliable communication protocols would be required to control the coordinated mesh release from neighboring clottocytes and also to regulate multidevice-activation radius within the local clottocyte population. As clottocyte-rich blood enters the injured blood vessel, the onboard sensors of clottocyte rapidly detects the change in partial pressure, often indicating that it is bled out of body. If the first clottocyte is 75 µm away from air-serum interface, oxygen molecules from the air diffuse through serum at human body temperature.[5] This detection would be broadcasted rapidly to the neighbouring clottocytes through acoustic pulses. This allows rapid propagation of a carefully controlled device-enablement cascade. The stickiness in the fiber mesh would be blood group specific to trap blood cells by binding to the antigens present on blood cell. Each mesh would overlap on the neighboring mesh and attract the red blood cells to immediately stop bleeding.[6]



Images of clottocytes

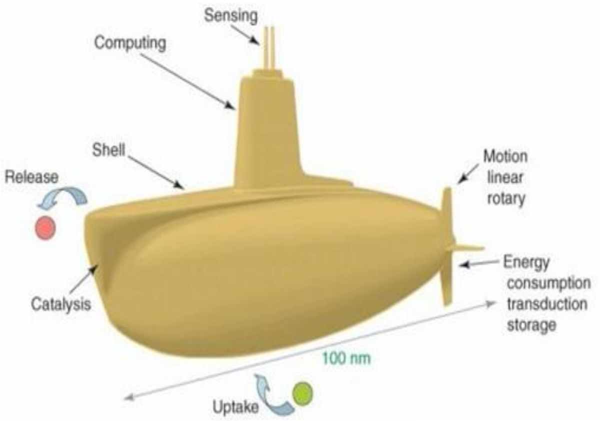
The clotting function by clottocyte is essentially equivalent to that of natural platelets at about 1/10,000th the concentration in the blood stream i.e. 20 clottocytes per cubic milimeter of blood. The major risk associated with the clottocytes is that the additional activity of the mechanical platelets could trigger the disseminated intravascular coagulation resulting in multiple micro thromb.[6]

4) Cellular repair nanobots

These little guys could be built to perform surgical procedures more precisely. By working at the cellular level, such nanorobots could prevent much of the damage caused by the comparatively clumsy scalpel.[8]

5) Pharmacytes

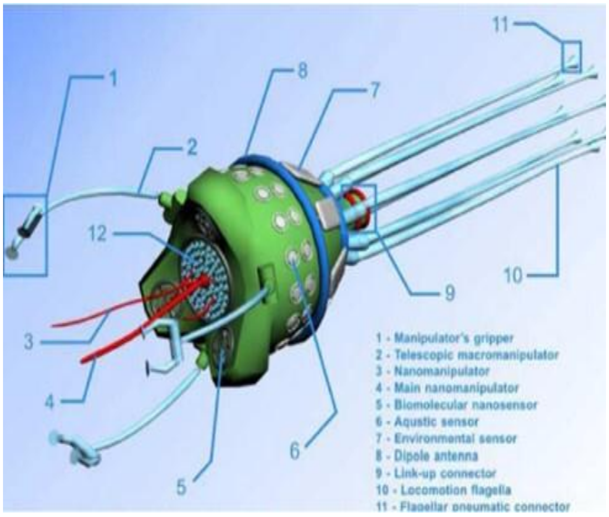
It is a medical nanorobot having a size of 1-2 μm able to carrying up 1 μm 3 a given drug in the tanks. They are controlled using mechanical systems for sorting pumps. They are provided with a molecular markers or chemotactic sensors that guarantee full targeting accuracy. Glucose and oxygen extracted from the local environments such as blood, intestinal fluid and cytosol are the on board power supply[7]. After the nanorobot completing tasks they can be removed or recovered by centrifuge nanapheresis.



6) Chromallocyte

Fictitious Pharmacyte

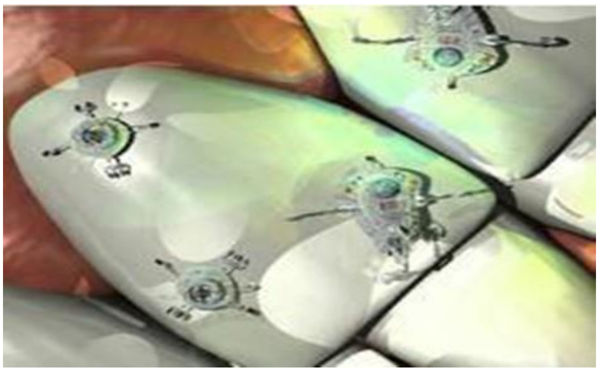
The Chromallocyte would replace entire chromosomes in individual cells thus reversing the effects of genetic disease and other accumulated damage to our genes, preventing aging. Inside a cell, repair machine will first size up the situation by examining the cell's contents and activity, and then take action by working along molecule-by-molecule and structure-by structure; repair machines will be able to repair the whole cell.[8]



Diamondoid Cell-Repair Nanorobot

7) Nanorobotic dentifrices (Dentifrobots)

These when delivered either by mouthwash or tooth paste, can cover all sub gingival surfaces, thereby metabolizing trapped organic matter into harmless and odourless vapours. Properly configured dentifrobots can identify and destroy pathogenic bacteria that exist in the plaque and elsewhere. These invisibly small dentifrobots are purely mechanical devices that safely deactivate themselves when swallowed.[5]



Dentifrobots.

Designing of Nanobots

- **Medicine cavity**

Medicine cavity a hollow section inside the nanorobot might hold small doses of medicine or the site of injury or infection. Nanorobots could also carry the chemicals used in chemotherapy to treat cancer directly at the site. Although the amount of medication is relatively miniscule, applying it directly to the cancerous tissue may be more effective than traditional chemotherapy, which relies on the body's circulatory system to carry the chemicals throughout the patient's body.[9]

- **Probes, Knives & chisels**

Probes, knives and chisels to remove blockages and plaque, a nanorobot will need something to grab and break down material. They might also need a device to crush clots into very small pieces. If a partial clot breaks free and enters the bloodstream, it may cause more problems further down the circulatory system.[9]

- **Microwave emitters & Ultrasonic signal generator**

Microwave emitters and ultrasonic signal generators to destroy cancerous cells, doctors need methods that will kill a cell without rupturing it. A ruptured cancer cell might release chemicals that could cause the cancer to spread further. By using fine-tuned microwaves or ultrasonic signals, a nanorobot could break the chemical bonds in the cancerous cell, killing it without breaking the cell wall. Alternatively, the robot could emit microwaves or ultrasonic signals in order to heat the cancerous cell enough to destroy it.[13]

- **Electrodes**

Electrodes two electrodes protruding from the nanorobot could kill cancer cells by generating an electric current, heating the cell up until it dies.[14]

- **Lasers**

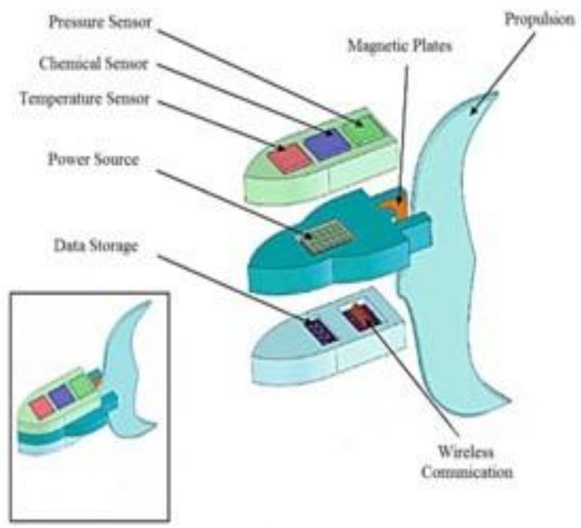
Lasers tiny, powerful lasers could burn away harmful material like arterial plaque, cancerous cells or blood clots. The lasers would literally vaporize the tissue. The two biggest challenges and concerns scientists have regarding these small tools are making them effective and making them safe. For instance, creating a small laser powerful enough to vaporize cancerous cells is a big challenge, but designing it sothat the nanorobot doesn't harm surrounding healthy tissue makes the task even more difficult. While many scientific teams have developed nanorobots small enough to enter the bloodstream, that's only the first step to making nanorobots a real medical application.

- **Sensors**

Temperature Sensor Integrated nanothermoelectric sensors could be at very low voltage levels, which is also a positive aspect, presenting good functionality and requiring little energy. Cantilever and bridge types are also valid techniques for possible different ways to implement CMOS thermoelectric sensors. Nanowires are suitable for fabricating CMOS based on integrated nanodevices. Carbon nanotubes are able to improve implemented as CMOS devices with promising uses in hydrology. Such approach may permit a large production of infrared thermal sensors applied into different ranges of wavelength with interesting possibilities for environmental monitoring. This same approach could be tailored for other application areas such as industrial manufacturing process or even medicine. CMOS as a thermoelectric sensor has advantage of linear self-generated response with system integration without requiring bias or temperature stabilization. Thus the infrared array could be integrated on a single chip within amplifiers and signal processing capabilities. Such approach allows a fast pace towards miniaturization with no loss of efficiency due electromagnetic noise. CMOS could be operated performance with low power.[13]

- **Propeller**

It is used for nanobots to drive foreword against the blood stream. These are made up of carbon nanotubes. The very first Feynman prize in Nanotechnology was awarded to William McLellan for building an electric motor that fit within a cube 1/64th of an inch on a side. This is probably smaller than we would need for our preliminary microrobot. One or several of these motors could be used to power propellers that would push (or pull) the microrobot through the bloodstream. We would want to use a shrouded blade design so as to avoid damage to the surrounding tissues (and to the propellers) during the inevitable collisions.[[14]



- **Nanocamera**

Nanobots may include a miature camera at the size of nanometer.

- **Fin**

A fin is a surface used for the stability or to proiduce a lift and thrust or to steer while travelling in water, air, or other fluid media. It is build in long with the propeller use to propel the device. These are fitted along with propeller used to propel the device.[9]

- **Molecular sorting rotor**

It is made of carbon nanotube. It is a class of nanomechanical device capable of selectivity binding molecules from solution, and of transporting these bound molecules against significant concentration gradient.[9]

- **Propulsion equipment**

Propulsion is in charge of the movement of nanobots, and this is the reason why many different motors and propulsion equipment in general have been designed. Nanomotors can be defined as nanoscale devices with their own propulsion, obtaining the energy by chemical reactions of the medium, electricity, magnetic or acoustic fields. Even so, nanotechnology presents great challenges to control movement on this scale; the main ones are due to the viscosity and Brownian motion. It should be noted that Brownian motion corresponds to the random motion of particles caused by the thermal collisions between the molecules of the solvent and the colloidal particles. In other words, the main problem is having a nanobot with sufficient energy to overcome the properties of a fluid in nanoscale and achieve movement.[13]

Size and shape of nanobotes

Nanobots are very fine robots. These are range from 1-100nm. They are small sized robots. The size and shape of nanobots are depend upon the functions of these. The technology of creating nanosized machines is called nanorobotics. This term, nanorobotics, refers to the section of nanotechnology that involves engineering, designing, and building of nanorobots. Nanorobots are devices ranging in size from 0.1 to 10 µm that are composed of nanoscale or molecular components. These devices can be injected into the patient to perform diagnosis or treatment on a cellular level. Such diagnosis or treatments involve the nanoscale, molecular, or atomic level. Treatments with nanorobots may involve alterations in structure and composition in the molecular or submolecular level.[14]

Shape of Nanobots

1) Nanobots 2) Nanoids 3) Nanites 4) Nanomachines 5)Nanomites 6) Nanospiders

- **Nanobots**

Nanoroboticsare an emerging technology field creating machines or robots whose components are at or near the scale of a nanometer (10^{-9} meters). More specifically, nanorobotics (as opposed to microrobotics) refers to the nanotechnology engineering discipline of designing and building **nanorobots**, with devices ranging in size from 0.1–10 micrometres and constructof nanoscale or molecular components. Theterms nanobot, nanoid, nanite, nanomachine, or nanomite have also been used to describe such devices currently under research and development.[13]

1) Nanites

Image of simple nanobot

A nanite was a microscopic device and a form of nanotechnology. A nanite was built by manipulating atoms and contained gigabytes of computer memory. The nanite were small enough to enter living cells.a nanomachine, also called a nanite, is a mechanical or electromecjhanical device whose diamensions are measured in nm (millions of a mm).[13]

2) Nanospiders

It would be interesting to note that the spider robots are **made of DNA molecules**. They can walk, turn right and left and create their own products. Developed at the molecular level, the robots represent DNA walkers, featuring legs to walk autonomously, though very slow – about 100nm in 30 meters – 1 hour. In order to observe the spider robots scientists used **atomic force microscopy**. The molecular robots managed to attract a lot of attention due to the fact that they can be programmed to sense the environment and react accordingly. For example, they can **detect disease markers on a cell surface**, identify whether it is a cancerous one and then bring a compound to kill it, if necessary, reports Daily Mail. Researchers consider that their latest invention is an important step in

molecular robotics. Although today this field cannot boast many great inventions, scientists and engineers believe that in the near future it could become one of the most important industries that could create devices for various medical applications.[13]

3) Nanomites

Nanomites, nano-mites or nanites are extreamly microscopic robot forms usually measuring the increadible scale of nanomerers. They have been used by both joe and cobra forces in their never ending battle to stop each other. These are more beneficial application such as in the field of medicine and construction.[13]

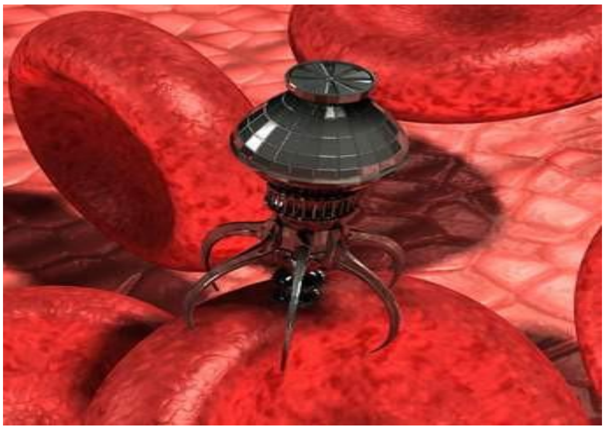
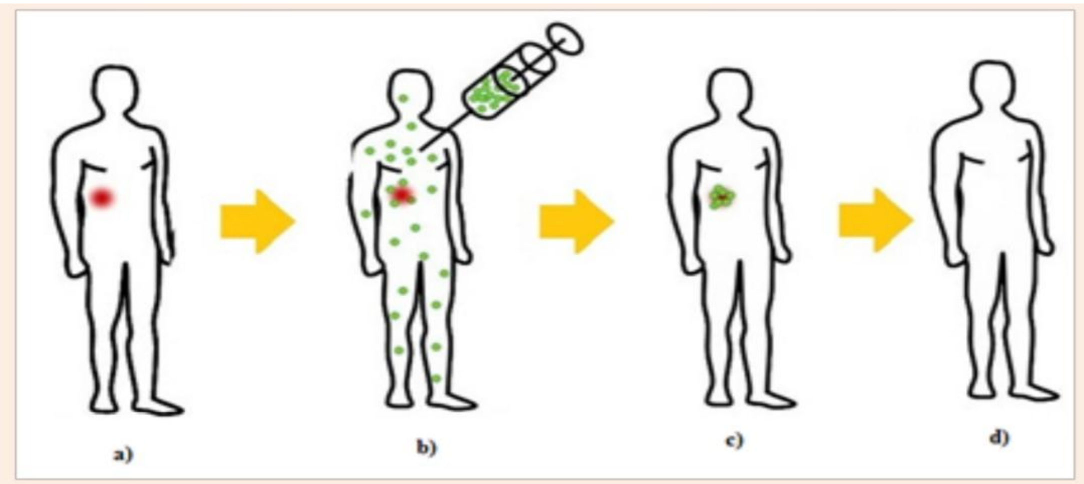


Image of nanomites

- **Introducing of Nanobots in the body**

Route of administration is determined by size of the nanorobot. Not only do we want to avoid damaging the walls of whatever blood vessel the device is in, we also do not want to block it too much. We have to get it into the body without being too destructive in the first place. The obvious candidate is the femoral artery in the leg Nanobots are introduced into the body by surgery. So nanobots are made smaller than the blood vessels as it can travel. The nanorobots are injected into the body through injection by femoral artery. The **femoral artery** is one of the major arteries in the human body. It extends from the iliac artery near the abdomen down to the legs. The primary function of this artery is to supply blood to the lower section of the body. Nanobots are directly injected into the blood stream.[14]



Nanobots injected into the human body

We need to find a way of introducing the nanomachine into the body, and allowing it access to the operations site without causing too much ancillary damage. We have already made the decision to gain access via the circulatory system, which leaves us with a number of considerations.

The first is that the size of the nanomachine determines the minimum size of the blood vessel that it can traverse. Not only do we want to avoid damaging the walls of whatever blood vessel the device is in, we also do not want to block it too much, which would either cause a clot to form, or just slow or stop the blood flow, precipitating the problem we want to cure in the first place. What this means, of course, is that the smaller the nanomachine the better. However, this must be balanced against the fact that the larger the nanomachine the more versatile and effective it can be. This is especially important in light of the fact that external control problems become much more difficult if we are trying to use multiple machines, even if they don't get in each other's way.

The second consideration is an even simpler one; we have to get it into the body without being too destructive in the first place. This requires that we gain access to a large diameter artery that can be traversed easily to gain access to most areas of the body in minimal time. The obvious candidate is the femoral artery in the leg. This is in fact the normal access point to the circulatory system for operations that require access to the bloodstream for catheters, dye injections, etc., so it will suit our purposes nicely.[14]

- **Nanobots navigation**

Methods of detecting the nanorobot include using X-rays, radio waves, microwaves or heat There are three main considerations scientists need to focus on when looking at nanorobots moving through the body -- **navigation**, **power** and how the nanorobot will move through blood vessels. Nanotechnologists are looking at different options for each of these considerations, each of which has positive and negative aspects. Most options can be divided into one of two categories: external systems and onboard systems.[15]

- **Magnetic resonance imaging**

External navigation systems might use a variety of different methods to pilot the nanorobot to the right location. One of these methods is to use **ultrasonic signals** to detect the nanorobot's location and direct it to the right destination. Doctors would beam ultrasonic signals into the patient's body. The signals would either pass through the body, reflect back to the source of the signals, or both. The nanorobot could emit pulses of ultrasonic signals, which doctors could detect using special equipment with ultrasonic sensors. Doctors could keep track of the nanorobot's location and maneuver it to the right part of the patient's body.

Courtesy NASA
plan to control and power nanorobots

- **Using MRI devics**

Using a Magnetic Resonance Imaging (MRI) device, doctors could locate and track a nanorobot by detecting its magnetic field. Doctors and engineers at the Ecole Polytechnique de Montreal demonstrated how they could detect, track, control and even propel a nanorobot using MRI. They tested their findings by maneuvering a small magnetic particle through a pig's arteries using specialized software on an MRI machine. Because many hospitals have MRI machines, this might become the industry standard -- hospitals won't have to invest in expensive, unproven technologies.[12]

- **Radioactive dye**

Doctors might also track nanorobots by injecting a radioactive dye into the patient's bloodstream. They would then use a fluoroscope or similar device to detect the radioactive dye as it moves through the circulatory system. Complex three- dimensional images would indicate where the nanorobot is located. Alternatively, the nanorobot could emit the radioactive dye, creating a pathway behind it as it moves through the body.

- **X-rays and other waves**

Other methods of detecting the nanorobot include using X-rays, radio waves, microwaves or heat. Right now, our technology using these methods on nano-sized objects is limited, so it's much more likely that future systems will rely more on other methods.1[3]

Onboard systems, or internal sensors, might also play a large role in navigation. A nanorobot with chemical sensors could detect and follow the trail of specific chemicals to reach the right location. A spectroscopic sensor would allow the nanorobot to take samples of surrounding tissue, analyze them and follow a path of the right combination of chemicals.

Hard as it may be to imagine, nanorobots might include a miniature television camera. An operator at a console will be able to steer the device while watching a live video feed, navigating it through the body manually. Camera systems are fairly complex, so it might be a few years before nanotechnologists can create a reliable system that can fit inside a tiny robot.

- **Locomotion of nanobots in the body**

Assuming the nanorobot isn't tethered or designed to float passively through the bloodstream, it will need a means of propulsion to get around the body. Because it may have to travel against the flow of blood, the propulsion system has to be relatively strong for its size. Another important consideration is the safety of the patient -- the system must be able to move the nanorobot around without causing damage to the host. Some scientists are looking at the world of microscopic organisms for inspiration. Scientists in Israel created microrobot, a robot only a few millimeters in length, which uses small appendages to grip and crawl through blood vessels.[14] The scientists manipulate the arms by creating magnetic fields outside the patient's body. The magnetic fields cause the robot's arms to vibrate, pushing it further through the blood vessels. The scientists point out that because all of the energy for the nanorobot comes from an external source, there's no need for an internal power source. They hope the relatively simple design will make it easy to build even smaller robots. Other devices sound even more exotic. One would use capacitors to generate magnetic fields that would pull conductive fluids through one end of an electromagnetic pump and shoot it out the back end. The nanorobot would move around like a jet airplane. Miniaturized jet pumps could even use blood plasma to push the nanorobot forward, though, unlike the electromagnetic pump, there would need to be moving parts.[13][11]

- **Working principle ofNanobots**

Once infected/damaged tissue is identified and then multiple programmed medical nanobots are introduced inside the infected patient body and nanobots automatically detect the infected/ damaged tissue, all the nanobots move to the infected tissue and use laser to remove infected/dead cells attached to the infected tissue. Once all the dead cells are removed and infected area is cleaned by the nano chemical then nanobot start repairing the tissue (similar to WBC (White Blood Corpuscles) does inside our body). All the work such as removing the dead cells, cleaning the infected area and repairing the cells may or may not be done by single nanobot hence we need multiple programmed nanobot. The whole process is so fast that patient can be healed as quickly as few hours for minor wounds and major wounds it may take up to few days to many days to recover completelyinclude all the drawbacks of using nanobots in the human body but one should not exceed the maximum prescribed amount of nanobots in the human body because increasing nanobots in the human body will also increase the toxicity in the blood and it may adverse the health of the effected patient. Although nanobots can be programmed to maintain the maximum amount in the human body and once maximum.[11]

- **How to remove nanobots from body**

Given sufficiently accurate control of the nanomachine, or a tether, this is not a problem; we can just retrace our path upstream. However, it would be a lot easier, and recommended, to steer a path through the body that traverses major blood vessels and winds up at a point where we can just filter the nanomachine out of the bloodstream. This will reduce the possibilities for difficulties, and also cause less wear and tear on the nanomachine. Of course, either scenario is a possibility, depending on where the actual operation site is. Another possibility is to have the nanomachine anchor itself to a blood vessel that is easily accessible from outside, and perform a small surgical operation to remove it.[15]\

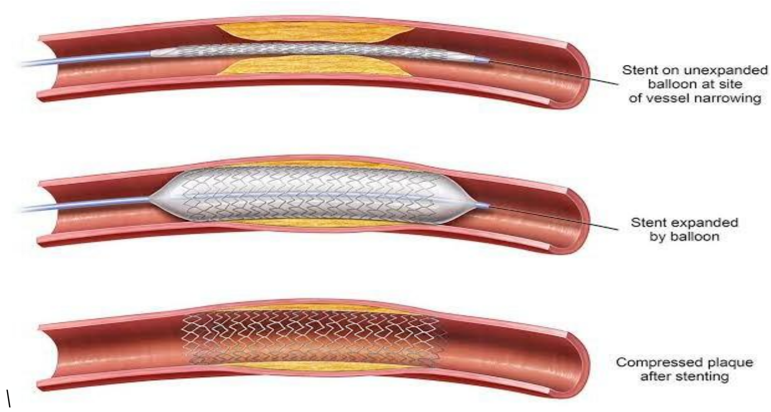
- **How to kill Nanobots**

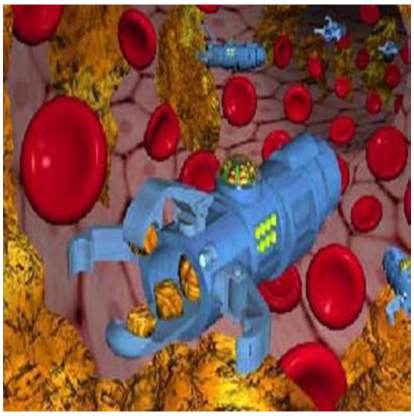
1) Electromechanical nanobots, the type of that many think of when they hear"Nanobot"' would have vulnerabilities. At first it would be kill such tiny machine, but wouldn't sufficiently strong electromagnetic pulse disrupt the operation of tiny device.
2) The nanobots can be deactivated or purged by a powerful magnetic pulse or electric shock.
3) A nanobot was directly in the path such that the current flowed through it, it not be might damaged at all. Also, for current to flow there must be potential voltage difference across it.
4) A magnetic pulse or field of sufficient strength might have better potential to harm a nanaobot, but that would require the nanobot contain material susceptible to magnetic field.
5) Chemical means such as drugs can damge specific microorganism or encourage the body's immune system to attack them, so a similar technique might be used to kill nanobots[11

- **Applications of Nanaobots**

1) Treating arteriosclerosis

Arteriosclerosis refers to a condition where plaque builds along the walls of arteries. Nanorobots could conceivably treat the condition by cutting away the plaque, which would then enter the bloodstream. Atherosclerosis is a major cardiovascular disease involving accumulations of lipids, white blood cells, and other materials on the inside of artery walls. Since the calcification found in the advanced stage of atherosclerosis dramatically enhances the mechanical properties of the plaque, restoring the original lumen of the artery remains a challenge. Modern medicine use high-speed rotational atherectomy, When performed with an ablating grinder to remove the plaque, produces much methods. However, the high-speed rotation of the Rotablator commercial rotational atherectomy device produces microcavitation, which should be avoided better results in the treatment of calcified plaque compared to other because of the serious complications it can cause. This research involves the development of a high-speed rotational ablation tool that does not generate microcavitation.[3]





Nanobots breaking fat clots

2) Breaking up blood clots

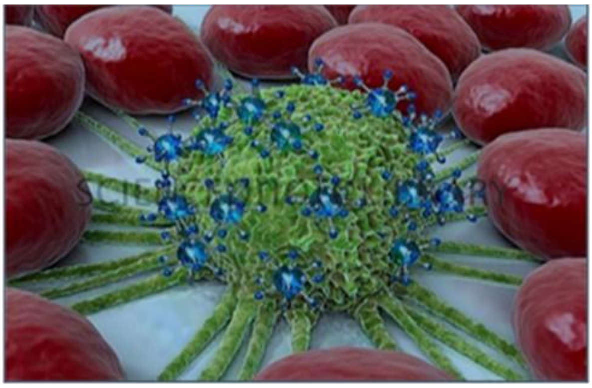
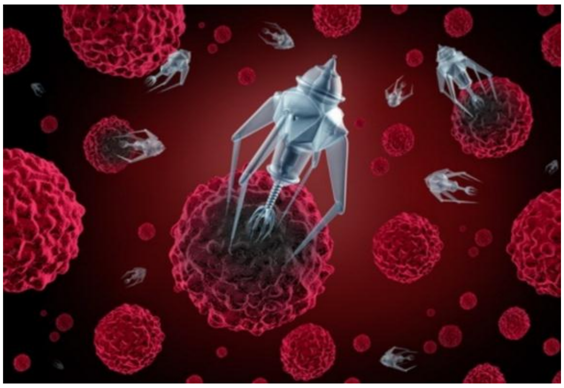
Blood clots can cause complications ranging from muscle death to a stroke. Nanorobots could travel to a clot and break it up. This application is one of the most dangerous uses for nanorobots the robot must be able to remove the blockage without losing small pieces in the bloodstream, which could then travel elsewhere in the body and cause more problems. The robot must also be small enough so that it doesn't block the flow of blood itself.[4]

3) Nanobots in cancer detection and treatment

The robots could either attack tumors directly using lasers, microwaves or ultrasonic signals or they could be part of a chemotherapy treatment, delivering medication directly to the cancer site. Doctors believe that by delivering small but precise doses of medication to the patient, side effects will be minimized. Many companies related with biotechnology are trying to find the correct way to manipulate the RNA (ribonucleic acid) and block genes which generate proteins associated with different diseases such as cancer, blindness or AIDS. However, this is the first mechanism which is able to enter in a cell and manipulate the RNA.

The nanorobots or nanoparticles are made with a mixture of a polymer and a protein called transferrin which has the capacity of detecting tumor cells because of its molecular particularities. Once they are in the cells the chemical sensor gives the order to dissolve; and when nanoparticles are dissolved they let free some substances which actuate on the RNA of each cell disabling the gene responsible of the cancer. Specifically, what the nanoparticles deactivate is the ribonucleic reductasa, the protein associated with the cancer growth which is fabricated by the disabled gene. It has been probed that the therapy with nanoparticles works, but it is very early to say that this will be the definitive cure for the cancer. There is another kind of nanoparticles for the treatment of the cancer: magnetic particles. These ones are used in a different way. When they arrive to the cancer cells, microwaves are applied from outside, the particles are excited and they burn the cancer cells.[2]

As cancer survival rates improve with early detection, nanorobots designed with enhanced detection abilities will be able to increase the speed of a cancer diagnosis and therefore enhance the prognosis of the disease. Nanobots with embedded chemical sensors can be designed to detect tumor cells in the body. Proposed designs currently include the employment of integrated communication technology, where two-way signaling is produced. This means that nanobots will respond to acoustic signals and receive programming instructions via external sound waves along with transmitting data they have accumulated.[2]

Nanorobots destroying cancer cells

4) Helping in removing the body clot:-

One particular kind of nanorobot is the clottocyte, or artificial platelet. The clottocyte carries a small mesh net that dissolves into a sticky membrane upon contact with blood plasma. According to Robert A. Freitas, Jr., the man who designed the clottocyte, clotting could be up to 1,000 times faster than the body's natural clotting mechanism. Doctors could use clottocytes to treat hemophiliacs or patients with serious openwounds.[3]

5) Parasite Removal

Nanorobots could wage micro-war on bacteria and small parasitic organisms inside a patient. It might take several nanorobots working together to destroy all the parasites. The microrobots can also be used to attack other life forms in the body. For example, they would be well suited to deal with such parasites as heartworms (hopefully in pets rather than humans), liver flukes (definitely in humans). As the sensor technology improves, they could be used to attack various bacteria and other smaller organisms as well, although this would probably require the introduction of large numbers of the units into the body. In essence, this would be creating artificial antibodies, and while this is the logical extrapolation of the technology, it will not happen for some time.[3]

6) Gout

Gout is a condition where the kidneys lose the ability to remove waste from the breakdown of fats from the bloodstream. This waste sometimes crystallizes at points near joints like the knees and ankles. People who suffer from gout experience intense pain at these joints. A nanorobot could break up the crystalline structures at the joints, providing relief from the symptoms, though it wouldn't be able to reverse the condition permanently. Gout occurs when the breakdown products of various fats cannot be removed from the bloodstream by the kidneys. These byproducts tend to crystallize at or near the joints, notably in the lower extremities, and cause excruciating pain to those who suffer from it. When a microrobot is in the bloodstream, it can locate these deposits by means of a combination of chemical sensors and external tracking, and can break up the crystals, allowing the bloodstream to carry them away. Of course, this will in no way prevent recurrence of the problem, but it will alleviate the symptoms for a time.[3]

7) Breaking up kidney stones

Kidney stones can be intensely painful the larger the stone the more difficult it is to pass. Doctors break up large kidney stones using ultrasonic frequencies, but it's not always effective. A nanorobot could break up kidney stones using a small laser. As anyone who has ever been plagued by kidney stones can attest, they are extremely painful, as well as being difficult to treat. In most cases, the pain must be endured until the stones have been passed. Attempts can be made to break up the stones by means of high intensity ultrasonics, but these attempts are difficult and not very successful.[3]

By introducing a microrobot of the type described in this paper into the urethra in a manner similar to that of inserting a catheter, direct access to the kidney stones can be obtained, and they can be broken up directly. This can be done either by means of ultrasonics directly applied, or by the use of a laser or other means of applying intense local heat to cause the stones to break up. If these techniques do not work, direct physical force by means of a sintered tungsten carbide cutting or abrasive surface could be used.[3]

8) Nanorobotics in drug delivery

For the specific drug delivery nano particals are used in the nanotechnology. Targeted drug delivery mechanisms for disease control and prevention.In this technique the active agent is deposited in the morbid region only hence the side effects can be reduced by providing proper dose at regular interval. Nanomedicines used for drug delivery.,are made up of nanoscale particles or molecules which can improved bioavilability.[14]

9) Nanobots in the hematology

Current research is developing nanorobotic applications for the field of hematology. This ranges from developing artificial methods of transporting oxygen in the body after major trauma to forming improved clotting capabilities in the event of a dangerous hemorrhage. Respirocytes are hypothetical nanobots engineered to function as artificial red blood cells. In emergencies where a patient stops breathing and blood circulation ceases, respirocytes could be injected into the blood stream to transport respiratory gases until the patient is stabilized. Current proposals suggest respirocytes would be able to supply 200 times more respiratory gas molecules than natural red blood cells of the same volume. Clottocytes are another type of nanobot which function as artificial platelets for halting bleeds. Clottocytes would mimic the natural platelet ability to accumulate at the bleed, in order to form a barrier, by unfurling a fiber mesh which would trap blood cells when the nanobot arrives at the site of the injury. The clotting ability of one injection of clottocytes would be 10,000 times more effective that an equal volume of natural platelets.[14]

10) Nanorobots in the Diagnosis and Treatment of Diabetes

Glucose carried through the blood stream is important to maintain the human metabolism working healthfully, and its correct level is a key issue in the diagnosis and treatment of diabetes. The hSGLT3 molecule can serve to define the glucose levels for diabetes patients. This protein serves as a sensor to identify glucose. The simulated nanorobot prototype model has embedded Complementary Metal Oxide semi-conductor (CMOS) nanobioelectronics. It features

a size of ~2µm, which permits it to operate freely inside the body. Whether the nanorobot is invisible or visible for the immune reactions, it has no interference for detecting glucose levels in blood stream. Even with the immune system reaction inside the body, the nanorobot is not attacked by the white blood cells due biocompatibility. For the glucose monitoring the nanorobot uses embedded chemosensor that involves the modulation of hSGLT3 protein glucosensor activity. Through its onboard chemical sensor, the nanorobot can thus effectively determine if the patient needs to inject insulin or take any further action, such as any medication clinically prescribed.
In the medical nanorobot architecture, the significant measured data can be then transferred automatically through the RF signals to the mobile phone carried by the patient. At any time, if the glucose achieves critical levels, the nanorobot emits an alarm through the mobile phone. In the simulation, the nanorobot is programmed also to emit a signal based on specified lunch times, and to measure the glucose levels in desired intervals of time.[13]

11) Cleaning wounds
Nanorobots could help remove debris from wounds, decreasing the likelihood of infection. They would be particularly useful in cases of puncture wounds, where it might be difficult to treat using more conventional methods.[10]

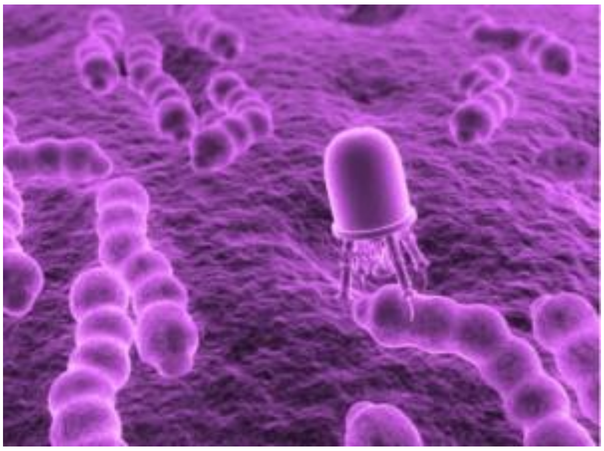
12) Nanobots in gene therapy
Medical nano robots can readily treat genetic diseases by comparing the molecular structures of both DNA and proteins found in the cell to known or desired reference structures. In some cases, chromosomal replacement therapy is more efficient than in CY to repair. Floating inside the nucleus of a human cell, an assembler built repair vessel performs some genetic maintenance. Stretching a super coil of DNA between its lower pair of robot arms, the nano machine gently pulls the unwound strand through an opening in its prow for analysis. Upper arms, meanwhile, detach regulatory proteins from the chain and place them in an intake port. The molecular structures of both DNA and proteins are compared to information Stored in the database of a larger nano computer positioned outside the nucleus and connected to the cell-repair ship by a communications link. Irregularities found in either structure are corrected and the proteins reattached to the DNA chain, which re-coils into its original form with a diameter of only 50 nanometers, the repair vessel would be smaller than most bacteria and viruses, yet capable of therapies and cures well be beyond the reach of present-day physicians. “Internal medicine” would take on new significance.[10]

13) An artificial oxygen carrier nanorobot
“Respirocyte” is the artificial mechanical red cell, an imaginary nanorobot which floats along in the blood stream. It is essentially a small pressure tank that can be pumped full of oxygen (O2) and carbon dioxide (CO2) molecules. Later on, these gases can be released from the small tank in a controlled manner. These atoms are mostly carbon atoms arranged as diamond in a porous lattice structure inside the spherical shell.

Outside of each device there are gas concentration sensors. When the nanorobot passes through the lung capillaries, O2 partial pressure is high and CO2 partial pressure is low, so the onboard computer tells the sorting rotors to load the tanks with oxygen and to dump the CO2. When CO2 partial pressure is relatively high and O2partial pressure relatively low the onboard computer commands the sorting rotors to release O2 and to absorb CO2. Respirocytes simulate the action of the natural hemoglobin-filled red blood cells, but they can deliver 236 times more oxygen per unit volume than a natural red cell.[13]

14) As artificial phagocyte (Microbivore):-
Microbivore is an artificial mechanical phagocyte of microscopic size whose primary function is to destroy microbiological pathogens found in the human bloodstream, using the “digest and discharge” protocol. The chief function of microbivore is to wipe out microbiological pathogens found in the human bloodstream, using the “digest and discharge” procedure. Microbivores upon given intravenously (I.V) would achieve complete clearance of the most severe septicemic infections in hours or less, far better than the weeks or months needed for antibiotic- assisted natural phagocytic defences.[12]

15) Nanorobotics in Surgery
Surgical nanorobots are introduced into the human body through vascular systems and other cavities. Surgical nanorobots act as semi- autonomous on-site surgeon inside the human body and are programmed or directed by a human surgeon. This programmed surgical nanorobot performs various functions like searching for pathogens, and then diagnosis and correction of lesions by nano-manipulation synchronized by an on-board computer while conserving and contacting with the supervisory surgeon through coded ultrasound signals. Nowadays, the earlier forms of cellular nano-surgery are being explored. For example, a micropipette rapidly vibrating at a frequency of 100 Hz micropipette comparatively less than 1 micron tip diameter is used to cut dendrites from single neurons. This process is not ought to damage the cell capability.[11]



Nanobots in surg

Advantages

There are many advantages of nanobots and one of the major advantage that author wants to point it out is that patient's whole tissue can repaired in few to some hours rather than in weeks or months and if programmed properly whole damaged organ can be repaired in few days. Another advantage is that once the tissue is repaired/healed completely, nanobots are not required to stay in the body forever, they can be moved out through programming. Below are the some of the advantage.

a. Nanobot might function at the atomic and molecular level to build devices, machines or circuits known as molecular manufacturing.
b. Nanobots might also produce copies of themselves to replace worn-out units, a process called self-replication.
c. The microscopic size of nano machines translates into high operational speed
d. Individual units require only a tiny amount of energy to operatee. The major advantage of nanobots is thought to be their durability, in theory.

With the help of nanorobots, we can further understand the complexity of human body and brain. The development will further help in performing painless and noninvasive surgeries. Even the most complicated surgeries will be done with ease. Due to their microscopic features they could surf through the brain cells and generate all the related information required for further studies. Scientist specially will be benefited from this nanotechnology application.

The best part is the nanobot are so small that it is not visible with naked eyes, so they can be injected in a human body very easily. Days in future will be like this when a single shot will cure diseases. We are yet to wait about 20 years before the first nanobot will be made to use.[16]

- Rapid elimination of disease
- No operation failure
- Less risk
- Faster diagnosis and treatment
- It might also produce copies of themselves to replace worn out
- Speed up medical treatment

DISADVANTAGES

The main disadvantage of nanobot is that increasing nanobots in the body will also increase the toxicity in the blood and may adverse the health of the effected patient. It should be noted that the maximum amount of nanobots in the human body should not exceed the prescribed amount. Below are the some of the disadvantages.[17]

a. Expensive technology.
b. Complicate design.
c. Initial design cost is very high.
d. Hard to program.
e. Limited external control mechanism.
f. May affect human health by introducing toxicity in blood

CONCLUSION

The nanobots are not an idea written on paper anymore, they are currently under development. The components are sensors, propulsion and navigation systems. Nowadays, the research is mainly focus on nanomotors; a key part of the propulsion component. Chemically, magnetic and acoustic driven nanomotors have been produced and applied; mostly in the field of nanomedicine. However, for medicine, a major effort should be done in technologies based on fuel free and biocompatible approaches. There is a lot of research, but it is going to be needed a lot more in order to create a functional nanobot, able to accomplish tasks beneficial for the human being; surface modifications, structures, components and body response has to be well understood. However, the quick development in nanotechnology, biotechnology and computing science will influence the prompt creation of nanobot. In this moment, we are still in the design and experimentation stage, even some patents are in the market.

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.

REFERENCES

1. Deepa R. Parmar, Julee P. Soni, Apexa D. Patel & Dhrubo Jyoti Sen, "Nanorobotics in advanced pharmaceutical sciences", International Journal Development & Research, April-june, 2010; 2(2): 247-256.
2. Ramna Tripathi, Akhilesh kumar, "Application of nanorobotics for cancer treatment", Review Of Research in the field of Nanorobotics, 2018, New Delhi, 1-15.

3. Rohit Kumar, Omprakash Baghel, Sanat kumar sidar, “application of nanorobotics”, International Journal of Scientific Research Engineering & Technology, Vol-3 ISSN 2278-0882, November 2014; 12-18.
4. Arun Raj R. “Nanobots-Medicine of the future” international journal of compressive pharmacy, volume 3 December 2012; 10-45.
5. R.A. Freitas, Current status of nanorobotics. Journal of computational and Theoretical Nanoscience, 2005, 2.1-25.
6. R.A. Freitas, Clottocytes; artificial mechanical platelets: 41, foresight Inc, 2000.
7. R.A. Freitas, Pharmacytes; an ideal vehicle for targeted drug delivery, Journal Nanosci Nanotechno/2006,2769-75
8. R.A. Freitas, The Ideal Gene Delivery Vector; Chromallocytes, Cell Repair Nanorobots for chromosomes replacement Therapy, The Journal Evolution and Technology, 2007, 16,1-97.
9. DHR International Journal of Pharmaceutical Sciences (DHR- IJPS), 2: 1.
10. Anita, E.- “introdiuction of Nanobots GRA” –global research analysis, Nov, 2012; 1(5): 45-48.
11. www. En. Wikiedia.org/wiki/Nanorobotics
12. www. Nanomedicine.com/Paper.NMRevMar05.pdf
13. www. Ncbi.nlm.nhi.gov/pmc/articles
14. Robotics and Mechatronic Reserch Lab., Dept. of Mechanical Eng., Monash University Clayton, Melbourne, VIV3800, Australia.
15. www. Researchgate.net.
16. Anti-HIVusing Nano Robots, Shrrutthii Harrsha, V. Venkatteswara Rap, Tata Consultancy Services, India, Department of Electrical Engineering, Texas tech University, U.S.A.
17. NANOROBOTS, Abhilashi M, Department of Biotechnology, The Oxford college of Engineering, Bangalore, INDIA.