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NANOROBOTICS – A REVIEW

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ABSTRACT: The world is heading towards more and more development day by day. The rise in new problems makes inevitable to invent more. There are new technologies which branch out the many applications when used in accordance with the proper requirements. Robotics is one such growing domain, which has a high scope and multi-tasking ability. Usually, the Robots now are of a normal human size, which is used in many industries or large scale workplaces, to reduce the tiresome works that tend to be done by humans manually. But now there is an inevitability of creating Micro-Nano sized robots, to solve some of the novel problems which are manually unreachable. There are many fields where the Nanorobots are going to be used. This paper gives a review about Nanorobotics which helps to know how far this technology has come.

KEYWORDS: Multitasking ability, Micro-Nano sized Robots, Manually unreachable functionalities.

I. INTRODUCTION

Richard Feynman (around 1959) was recommended by Albert Hibbs for the medicinal potential of Feynman's imagined micro machines. This created the potential that certain fix machines could one day be reduced in size to the point where it would be possible to "swallow the surgeon," as Feynman put it. Norio Taniguchi, a professor at Tokyo University of Science, created the term in Nanotechnology in 1974. Taniguchi described thin-film deposition and ion beam milling in semi-conductors with characteristics control on the order of a nanometer; nanotechnology is primarily concerned with the separation, consolidation, and deformation of materials by one atom or one molecule. He researched machining advancements and correctly forecasted in the late 1980s. Second Gerd Binnig and Heinrich Rohrer invented the scanning tunnelling microscope in 1981. Fullerenes were found as molecule scale electronic in 1985 by Harry Kroto, Richard Smalley, and Robert Curl. Robert Freitas suggested a hypothetical exchange of nanorobotics in the therapeutic setting of nanomedicine, encompassing specific design challenges such as sensing, power communication, route, control, movement, and locally available calculation (circa 1999) [1]. Nanorobotic devices are expected to be among the most powerful instruments humanity has ever made. These technological devices, often known as nanobots or nanorobots, range in size from 0.1 to 10 micrometres. Nanotechnology makes use of devices that are especially developed with molecular or nanoscale components. Nanorobots can be compared to any other self assembling robotic device (such as those used in auto manufacturing). The main difference is that nanobots assemble their products using the atomic building components of matter. Although some may dismiss this concept as science fiction, it is important to remember that our bodies contain many "nanobots" that work in every activity to keep our bodies functioning properly. These biologic entities can also be referred as cellular components that are responsible for Deoxyribonucleic acid (DNA) replication, rather than nanobots [2].

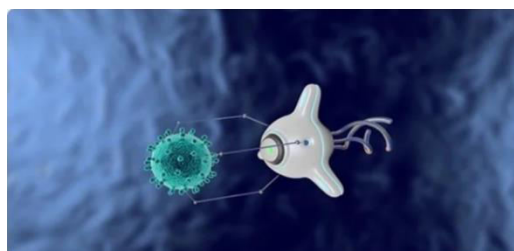


Fig 1: Nanorobot attacking a virus [2]

There was an emergency in many fields and domains for nanobots to be invented, where it has many applications in solving real time problems quickly. There is a different mechanism for the nanorobot to be built, components used, assembling the components, methods used accordingly for different applications as the nanorobot is not found as a fundamental technology that can be generally used for various application. It solves various problems which cannot be manually done due to too tiny objects that exist in our nature.

II. COMPONENTS AND WORKING OF NANOROBOTS

Carbon (often referred to as the ^{13}C isotope) in the form of carbon nanotubes (CNTs) or carbon nanotube CMOS biochips (CNT CMOS biochips) is the primary building block of Nanorobots. Due to its inherent strength, inertness, and other properties, it is fabricated in Nano factories dedicated to this purpose [3]. Power supply, fuel buffer tank, sensors, sorting motors, propeller, manipulators, onboard computers, pumps, pressure tanks, and structural support are among the Nanorobot's different components. Payload, Micro camera, Electrodes, Lasers, Ultrasonic signal generators, Swimming tail, motor, or mechanical leg are some of the substructures of a Nanorobot. An on-board computer controls and monitors them [3].

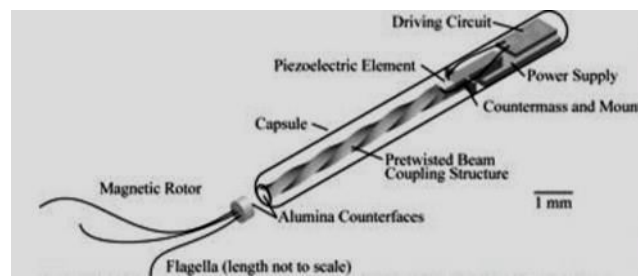


Fig 2: Components of nanorobot [1]

It works on the three basic procedures discussed one by one-

Sensing The mobility of artificial nanomotors with functionalized various bio sensors is used in the nanorobot sensing approach. These sensors are designed in such a way that they may be inserted into structures with vision. They're used to track the robot's position and measure its velocity.

Actuating An actuator is a motor that is responsible for moving or controlling a device or framework. It is powered by a source of vitality, which is typically an electric flow, water-driven liquid weight, or pneumatic weight, and it converts vitality into movement. An actuator is the part of a control framework that responds to a situation. The control framework might be simple (a fixed mechanical or an electronic framework), programming based (for example, a printer driver or a robot control framework), human-controlled, or depending on other data.

Propulsion Positional route by dead retribution, cartotaxis, full scale/miniaturized scale transponder systems; setting up whole or relative physical situation crosswise across multiple systems, including circulation system, tissues, organs, and cells. Regulation of progress crosswise over cell-covered tissue surfaces, amoeboid movement, or inchworm motion, control of explicit in vivo velocity frameworks such as ciliary or catch frameworks, surface disfigurement, slanted planes/screws, volume relocation, and gooey tying down frameworks.

Control stowage, recovery, choice, establishment, use, and separation of tooltips and opposing end-effectors; the board of hardware and controller carports; the directors of aided controller clusters; and the command of locally available transfer or dismantling frameworks such as morcellation, granulating, sonication, warm or concoctiondeterioration frameworks.

Programming and co-ordination Each nanorobot will have limited capabilities on its own, but the combined efforts of many will yield the needed system-level effects. Coordination is required for communicating, perceiving, and action across the board, and it is a key scientific challenge. Nanorobotic systems' scale and dynamics limit centralized coordination and global state sharing. As a result, we require

distributed coordination methods with localized inputs, algorithms, and outputs [1, 4].

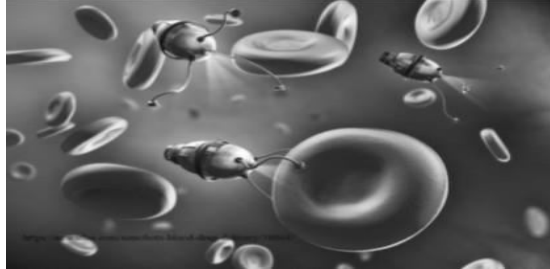


Fig 3: Nanorobots swimming in the blood stream [1]

Nanorobots react to external stimuli such as the temperature of a chemical reaction or radio waves. During the design process, the way a nanorobot moves in a liquid environment is crucial. It's critical that the device can navigate in the blood environment with a smooth trajectory path while causing no damage to other cells. In order to propel its tentacles forward precisely in time to capture the infectious cell once it is spotted, the tentacles must have a rapid response rate.

Switch: Nanorobotic switches work by transferring charge from "off" to "on" position in response to external stimuli. A conformational change occurs when a nanobot's shape changes in response to external upgrades.

Motor: A nanomotor is more complex than a nanorobotic switch because it may use the energy generated by the conformational shift to drive physical growth in the surrounding particles.

Shuttle: A nanorobotic transport refers to a device that delivers specific pharmaceuticals or synthetic chemicals to a specific location. Researchers are currently seeking to match these with nanomotors in order to give them more control over how they travel in their current state.

A nano-smart box: The team built a drug-delivery vehicle with two lock mechanisms by combining advanced structural design with the DNA origami process, which allows the cargo to be locked within the structure using a basic, one-lock method. "The nanorobot described by Douglas... is a 'smart box' for other molecules – a box that opens if and only if it detects keys for locks put on its lid," explained Rothmund, who was not involved in the research. "This means that, for example, if it is keyed to proteins on the surface of cancer cells, it can be used to transport medications to cancer cells (and only cancer cells), potentially lowering side effects dramatically". Douglas and his colleagues even managed to put two different locks on the lid of the box, so that it will only open if both keys are found, according to Rothmund [3].

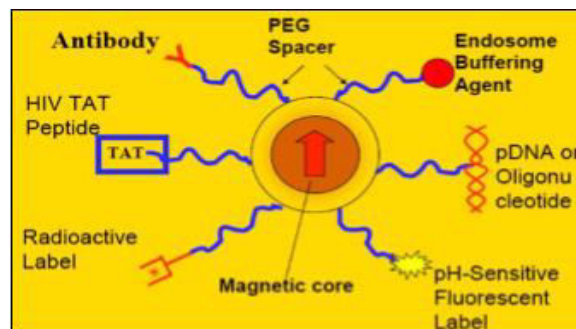


Fig 4: Smart nanorobot [5]

III. NANOBOT AS BIOLOGICAL MOLECULAR MACHINE

The main goal in the field of biological molecular machines is to use various biological elements whose function at the cellular level creates motion, force, or a signal as machine components. In an artificial situation, these components may be employed to fulfill their preprogrammed biological function in response to precise physiochemical stimuli. Proteins, for example, could serve as motors, mechanical joints, transmission elements, sensors, and other biological structures (Mavroidis and Dubey, 2003). All of these diverse components could be properly integrated to produce nano devices with various degrees of freedom capable of applying force and manipulating objects in the tiny realm. Biomolecular



motors have gotten a lot of interest since they have exceptionally high efficiency (some are close to 100%), can self-replicate, and are abundant in nature. Proteins make up the majority of natural molecular machineries. Proteins are used by nature to conduct a variety of biological functions, from transporting cargo to catalyzing processes [6, 7].

IV. TYPES OF NANOBOTS

With regard to applications, the most common forms of Nanorobots are listed below:

Respirocytes are spherical, blood-borne, artificial mechanical red blood cells with a diameter of one metre. Diamonds make up the outer shell. They have molecule-selective pumps that are reversible. Respirocytes use three rotors controlled by an integrated Nanocomputer to transport oxygen and carbon dioxide molecules throughout the body. When compared to natural red blood cells, the Respirocyte would supply 236 times more oxygen to the bodily tissues [5].

Microbivores are artificial white blood cells or Nanorobotic phagocytes, which are a spheroid device composed of diamond and sapphire with a major axis diameter of 3.4 meters and a minor axis diameter of 2.0 metres. Microbivore's major role is to phagocytose pathogens in the bloodstream and absorb and digest them utilising its in-built fundamental components, which include an array of reversible binding sites, telescoping devices, a morcellation chamber, and a digesting chamber [5].

Clottocytes are cells that form clots. Hemostasis is the clotting of blood that occurs when platelets damage the endothelial cells of blood arteries. Natural blood clotting can take anything from 2 to 5 minutes. Nanorobots, on the other hand, decrease clotting time and blood loss by directly administering corticosteroids to the wound site. It comes in handy when ribs pierce the lungs during accidents, brain haemorrhage, Cerebrospinal fluid (CSF) leaking, and other situations. The following is the solution to the question, "What does the Nanorobot do when it arrives at the site or target" [5].

With respect to the type of materials used in Nanorobots they are categorized as:

Organic Nanorobots Viruses and microscopic organisms' DNA cells are used to create natural nanorobots, known as bionanorobots. The biological form is less likely to be killed by such a nanorobot [1].

Inorganic Nanorobots Made by using Diamonds, integrated proteins, and other materials make up inorganic nanobots. These types of robots are becoming increasingly poisonous; one strategy for reducing this issue is to exemplify the robot; this strategy also keeps the robot from being destroyed by the body's defense framework; this issue has been a significant test examined by experts.

Researchers can figure out how to regulate tiny scale measurements and nano-sized devices with catalytic reaction using information about natural engines of living cells [1].

V. CREATION OF CELL-REPAIR MACHINES

Nano-scale manufacturing techniques are now allowing bacteria-sized mechanizations to recognize one cell from another by touch, repair DNA within a cell, and even be directed by computers to fulfill numerous missions in the same body. The development of genuine nano-scale robots would revolutionize medicine. Such robots, made of carbon for strength, would have to be no more than 3 nanometers in size at their maximum dimension to fit through capillaries and other passageways necessary for their transportation and utilization in the human body. Such robots might be injected into the body, operated by nano computers, and monitored by magnetic resonance imaging (MRI). Early illness detection is a term that refers to the detection of a disease when it is still in its early stages. Sensor testing chips containing thousands of nano wires could eventually be used to test for diseases on a cellular level. These tiny sensors could detect proteins and other biomarkers left behind by cancer cells. As a result, they may be able to aid in the early detection of such disorders. It all started with a few drops of blood [8].



Fig 5: Nanobots fixing individual blood cells [8]

VI. NANOROBOTS UNDER MAGNETIC FIELD CONTROL IN A GRID NETWORK

The nanobots used are biocompatible hydrogel-based robots that can be manipulated with the help of a magnetic field generated externally. Polystyrene and iron oxide can be magnetically actuated with a rotating magnetic field and manipulated to move independently using vision-based feedback control. A custom-built approximation Helmholtz coil system is constructed to assess magnetic responsiveness and actuate their motion. The system comprises of three pairs of electro-magnetic coils organised in a roughly Helmholtz configuration, three power supply, a data collection controller, a computer, an inverted microscope, and a camera, as indicated in the diagram. The power supplies are configurable, and a Data Acquisition (DAQ) controller can generate sinusoidal outputs to the coils to create a spinning magnetic field. The camera gives visual feedback and records videos at a resolution of 1280*1024, at 30 frames per second. The computer serves as the camera's and DAQ controller's control interface. The following are the setup parameters for the experiment: Under a 10x lens, the viewing range is 614.4 x 491.5 μm , with a resolution of 0.48 $\mu\text{m}/\text{pi}$. Different magnetic particles were employed in two experiments: Touchable computation (TouchComp) employs magnetic particles with a diameter of 10 μm , whereas Touchable communication (TouchComm) employs particles with a diameter of 4.20.5 μm [9].

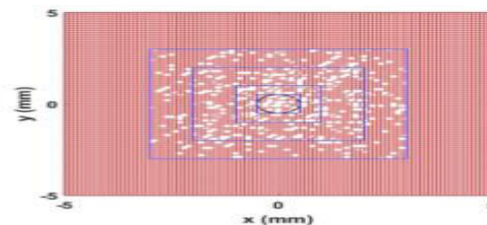


Fig 6: Nanobots under magnetic field grid [9]



Fig 7: TouchComm and TouchComp experiment [9]

TouchComm: The nanobots are designed to take a defined route to a defined target place for the TouchComm in the fractal-based channel. From the nanobot's current location, the guiding magnetic field is kept pointed to the target. The magnetic field always points to the midpoint of the right border of the picture in the experiment, and the beginning locations are along the channel's centre line, which fluctuates with the movement of the nanobots. As a result, as nanobots migrate, the angle does not remain constant. The model's blood arteries are kept straight and not curved between the two branches, resulting in a consistent angle change rate. We were able to evaluate whether the control method can effectively guide nanobot movement in surroundings with uncertain resolution by comparing the volume of nanobots admitted into two daughter branches [9].

TouchComp: TouchComp can be viewed in terms of Gravitational Search Algorithm (GSA): the agents attempt to locate the tumour region in the search space and evolve based on the knowledge provided by their interactions with the search space. It is assumed that the external system runs in a straightforward time-multiplexed way due to the uniform field limitation. Each nanobot now has three modes of operation: intentional actuating (IA), imaging and tracking (IT), and Unintended actuating (UA) The angle deviation relative to a principal axis representing an intended steering vector onto the nanobot, which implies a uniform magnetic field in the surveillance domain, determines the nanobot's route in IA mode. In the absence of a steering field, the nanobot in IT mode does a random walk through the search space. The UA mode operates similarly to the IA mode, with the exception that the steering field is intended for other nanobot. The orthokinetic GSA (OGSA) and the weak priority evolution strategy (WP-ES) for the TouchComp model are proposed here, based on the analysis [9].

VII. NANOROBOT ARCHITECTURE IN MEDICAL DEFENCE

Application Specific Integrated circuit (ASIC) should be used to build the medical nanorobot for biohazard protection. The architecture must handle capabilities for common medical applications, including an asynchronous interface for the antenna, sensor, and a logic nano processor capable of deliberating actuator and ultrasound communication activation as necessary [10].

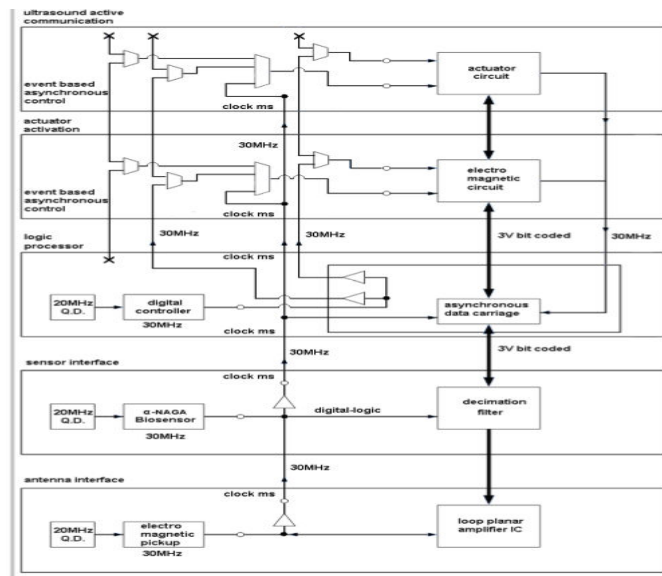


Fig 8: Architecture of a Nanorobot under Medical purpose [10]

VIII. APPLICATIONS OF NANOBOTS IN VARIOUS FIELDS

Cancer treatment: Cancer cells can be detected and cured using nanorobots. Nanorobots can perform and coordinate tasks such as tumour detection, diagnosis, and nanomanipulation annihilation. Nanorobots equipped with chemical biosensors can be utilised to detect tumour cells in their early stages of development within the body of a patient. As a result, for the role of nanobots in cancer treatment, bioelectronics-based hardware architecture is used. The nanorobots can discriminate between different cell kinds, such as cancerous and benign cells. Nanorobots detect surface antigens that are different for distinct cell types throughout the detection process. It accomplishes this by employing antigen-specific chemotactic sensors. The detection of varying levels of E-cadherin and catenin in the primary and metastatic phases is another method. E-cadherin is a long-range adhesion protein that is calcium-regulated in epithelial cells. It's a classic tumour suppressor gene that also serves as a biomarker for cancer cell identification [11, 12, 13, 14, 15, 16, 17, 18].

Diabetes treatment: A normal glucose level in the body is required for the proper functioning of human metabolism. In order to diagnose diabetes, the level of glucose in the body is tested. Protein Human sodium-Glucose-Cotransporter-3 (hSGLT3) is necessary for the appropriate functioning of gastrointestinal cholinergic nerve and skeletal muscle function activities. The protein is required for the control of extracellular glucose. This protein also serves as a glucose

level indicator. Patients with diabetes must obtain a little blood sample to monitor and manage their blood glucose levels. This treatment is extremely inconvenient and unpleasant. To avoid this problem, medical nanorobots that continuously monitor glucose levels in the body can be used to check sugar levels in the body. This data can assist doctors and specialists in providing real-time health care to patients, allowing them to improve their pharmaceutical regimen. It provides glucose monitoring all over the body. The nanorobots scan the body for the presence of glucose in the blood. The rate of change in glucose concentration in the blood moving through a certain organ, tissue, capillary bed, and the vessel can be accurately measured by examining data obtained from various regions of the body. Nanorobots provide a precise measurement of the rate of change in blood glucose content. Nanorobots can also detect which tissues have been affected by the diabetic issue and to which level [11, 16, 17].

In heart surgery: The heart's blood veins transport blood throughout the body. This flow is reduced as a result of the buildup of fatty materials, resulting in heart attacks and damage to key organs. The coronary artery narrows as a result of this. Currently, heart bypass surgery or angioplasty surgery is utilised to treat these issues. Coronary Artery Bypass Grafting Surgery (CABS) is a procedure that is performed to treat coronary artery disease or artery constriction. The heart muscles receive oxygen and nourishment through the coronary artery. In CABG, an autologous vein is used for grafting. CABG surgery can cause obesity, sternal wound infection, leg infections, and atrial dysrhythmias, among other complications. Incisions are made in the centre of the chest during CABG surgery. There is a global death rate of 12.1% and a 6.2% average country rate. The procedure entails open cardiac surgery with a mid-chest incision. Leg veins are employed in the grafting process. The coronary artery is connected to one end of the vein, while the aorta is connected to the other. This procedure will take approximately 4 hours. The traditional procedure carries various health risks for the patient. Nanorobots can be used to prevent these types of behaviours. Nanorobots are both safe and rapid, and they offer a better method of destroying plaque that has accumulated in the vessels [11, 16, 17, 18].

In brain aneurysm: Patients' health is at stake when using the traditional method. Nanorobots can be used to stop this from happening. Nanorobots are both safe and rapid, and they offer a more effective method of removing plaque from vessels. The rupture causes blood to leak into the surrounding tissue, which might result in a stroke, lasting nerve damage, or death. A subarachnoid haemorrhage, or bleeding into the space between the skull bone and the brain, is the most common complication of an aneurysm rupture. Aneurysms can be acquired, and patients with specific hereditary illnesses are more likely to develop them. A brain aneurysm, in most situations, does not cause symptoms and hence goes unreported. Computed tomography (CT) scans, computed tomography angiogram (CTA) scans and magnetic resonance angiography (MRA) are commonly used to identify this problem [12, 16, 17].

In dentistry: Nanotechnology has resulted in the birth of a new field known as nano dentistry, owing to the increased future interest in the subject of dentistry. Local anaesthetic, dental renaturalization, hypersensitivity treatment, orthodontics, and dentifrices are all examples of nano dentistry. Researchers Goene et al, 2007, Freitas, 1999, identified the dental perspective for the nanorobot, which contains atomic ingredients essential to create nanoparticles and the building of nanoscale objects. These nanorobots might employ a specialised mobility system to navigate, collect energy, sense, and penetrate human tissue, and then manipulate the surroundings. Nanorobots are controlled by onboard computers, which are supported by pre-programmed functional events and directives. Acoustic signals are used to transmit the instructions [12, 16, 17, 18, 19].

In oral-anaesthesia: Patients' gingiva are injected with a colloidal suspension containing active micro-sized nanorobots. The stimulus produced by the dentist causes these nanorobots to react. Nanorobots migrate into the gingiva sulcus, lamina propria, or dentine tubule to reach the pulp. By managing nerve signals, nanorobots shut down all senses as soon as they reach the pulp. The advantage of employing this procedure is that it is faster and has less side effects and complications. After the work is completed, the dentist instructs the nanorobots to restore full sensation. Nanorobotic anaesthesia improves patient comfort and compliance while lowering anxiety and increasing the sensitivity and controllability of the analgesic effect. It prevents the majority of adverse effects and problems [16].

In gene-therapy: The majority of human diseases are caused by cellular malfunction. Gene expression controls cell function and protein production. As a result, many diseases are defined by defective chromosomes or gene expression. Incorporation of new genetic material into the cell by bacteriophage, virus, dendrimeric, nanoparticulate, cationic liposome, plasmid and phospholipid microbubble, stem cells, bacterial or any other vector to rupture the cell membrane is currently used as a treatment for such problems. Permanent gene substitution has failed due to immunological responses to the antigen of viral carriers. Some of the procedures used in this therapy include electroporation, nucleofection, and laser. Since the 1970s, direct chromosomal extraction has been practised. Today's effective



procedures include nuclear transfer and nuclear transplantation. Chromosome Replacement Therapy (CRT) is the process of replacing an existing set of chromosomes with a new set of chromosomes. Full replacement of original DNA can cause problems such as XXY syndrome, congenital heart disease, and cancer. This is a hypothetical application of nanorobots. CHROMALLOCYTES are nanorobots that are utilised to repair cells. These chromalloytes are injected into the body, where they go to the target and enter the nucleus. All genetic abnormalities can be cured with chromalloytes, which are perfect for gene substitution. It would deliver a cure that is 100% effective and comprehensive [11, 16, 17].

In tissue repairing: Bone structure can be reconstructed using nanorobots containing nanoparticles. The nanorobots are made in the same way that bones are. In the process of bone rebuilding, ultrasound is used. Ultrasound imaging provides images of muscles, joints, tendons, and ligaments all over the body. Tears, strains, and soft tissue diseases can all be diagnosed using ultrasound. As a result, ultrasonic imaging is used. Nanostructures are created based on the pattern received through ultrasound. Nanorobots are used to place these bone-like structures inside the body. These nanoparticles containing nanorobots assemble themselves when they reach the damaged bone. The arrangement is designed to generate a bone-like structure that will eventually become a component of the bone. As a result, nanorobots of this type can be used [16, 18].

In treating Kidney diseases: Nanoscale engineering developments will enable manageable and controllable devices to be used to treat renal disease. The nanoscale gadgets have been created in such a way that they will work with kidney cells and other structures. This necessitates a grasp of the chemical and physical features of renal cells and tissue. These need to be investigated down to the atomic level. Major renal problems can be treated with advanced techniques. Extracorporeal Shockwave Lithotripsy, Percutaneous Nephrolithotomy, and Ureteroscopic Stone Removal are some of the procedures used to dissolve kidney stones at the moment. However, there are certain disadvantages to these treatments, such as discomfort and other side effects. Shock waves turn stones into a sand-like substance, raising the risk of diabetes and high blood pressure. As a result, effective treatment is required to complete this procedure. The laser might be used by nanorobots to destroy kidney stones. Small ultrasonic signal generators on nanorobots will transfer frequencies to stone and destroy it. These tiny particles are going to be excreted through the urine [16].

In haematology: Nanorobotic applications for the field of haematology are currently being developed. This includes everything from establishing artificial methods of transferring oxygen in the body after serious damage to improving clotting ability in the event of a dangerous bleed. Respirocytes are fictitious nanobots designed to act as artificial red blood cells. Respirocytes could be injected into the bloodstream to carry respiratory gases until the patient is stabilised in an emergency where a patient stops breathing and blood circulation stops. According to current theories, respirocytes could supply 200 times more breathing gas molecules than natural red blood cells of the same volume. Clottocytes are another form of nanobot that act as artificial platelets to stop bleeding. Clottocytes would imitate the ability of natural platelets to clump together at a bleed site to form a barrier by unfurling a fibre mesh that would capture blood cells as the nanobot approached the injury site. One injection of clottocytes has a clotting potential 10,000 times greater than an identical volume of normal platelets [14, 18].

Anti - HIV: Acquired Immuno Deficiency Syndrome (AIDS) isn't a life-threatening disease on its own. The Human Immunodeficiency (HIV) virus, which can destroy the immune system, is the source of AIDS. Thereby the host system is vulnerable to small diseases which will turn into a fatal one but actually it is not a fatal disease. The HIV virus attacks the White Blood Cells (WBC) by converting them into the HIV. As a result, all WBCs are transformed to HIV, and the immune system is compromised. This was the cause of the patient's death. Here the concept is to use a Nanorobot to convert AIDS-affected WBCs back to their natural form, allowing the patient to maintain a steady level of immune system. The HIV process is reversed by the Nanorobot. The WBC is converted more quickly by HIV. As a result, the Anti-HIV Nanorobot's conversion should be significantly faster than HIV's, ensuring that a consistent amount of WBCs is maintained in the bloodstream. As a result, an AIDS patient can defend himself against a variety of diseases. The rate of conversion should be at least five times higher than the HIV conversion rate [20].

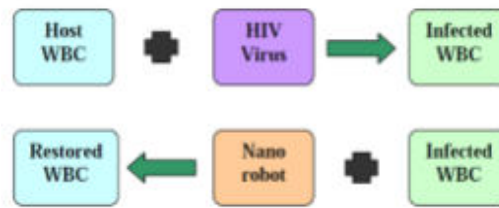


Fig (9): Conversion of HIV infected cell to normal WBC [21]

In drug-delivery: It's fair to say that discovering a pharmacological system that solely targets cancer cells while leaving healthy cells alone is cancer research's holy grail. A group of scientists from Harvard's Wyss Institute made a significant step toward this aim two years ago when they designed and built a nanobot that can autonomously select a cancer cell and deliver a payload of chemotherapy medications. The nanobots developed at Harvard, on the other hand, are far simpler, and instead of killing, they were created to save lives. It's so simple that you wouldn't guess it's a machine at first glance. The gadget is very small, with a width of only 35 nanometres. To put this in perspective, it's around 200 times smaller than a red blood cell. The finished nanobot resemble a nanocage with an open end, skin to a barrel. This molecular barrel is made up of two sections that can open and close like a clamshell. These two parts are joined by molecular hinges and held together by two molecular locks or latches, which are comprised of DNA double helixes. The chemotherapeutic agent can be inserted into the barrel core and held in place inside the nanocage by molecular anchors. To do so, scientists must add a linker strand to the medicine molecule, which is formed from a short strand of DNA. The nanobots and the medications are simply mixed together to load the medicines. The mutual attraction between the linker strand and the molecular anchors inside the nanocage causes the chemotherapy agent to simply permeate into the inner structure of the nanocage [13, 21, 22, 23].

Whole brain monitoring: The system design to monitor the brain is Neural electrical data processing system. If there are "relevant" changes to the input/output of action potentials that interact with a structural component, such as a neuron or a synapse, that structural component should be regarded as a processing unit. As a result, a metric to assess the changes' significance is required. Although there is considerable agreement in the literature that neurons and synapses should be regarded processing units, there is no consensus on whether dendritic trees, axons, proteins, or neural microtubules should be viewed as processing units. Because action potentials are used to receive, integrate, create, send, and relay information, neurons are electrical information processing units. Electrical data is largely received by neurons through their dendritic tree, which they then integrate in the soma. In the axon hillock and axon initial segment, neurons generate new information in the form of action potentials, convey the action potentials through the axon, and transfer the information to the next neuron cell via synapses. It is never tried quantify the functional significance of these several processing steps in brain information processing in this research. Synapses are an important component of the neuron network that processes information and aids learning and memory. Both long-term and short-term memory storage and deletion are said to be influenced by synapse size and structure. Synapses enable one-way signal transmission in most circumstances, allow for more complicated system behaviours, and are essential for signal transduction and plasticity. The utilisation of dynamic synapses increases a network's computational capability, and synapses are important in temporal information processing, according to theoretical conclusions. Emulation of biological synapses is thought to be a necessary component of brain-like computer systems. As a result, we consider synapses to be the most important electrical processing units in the human brain [24].

On-Chip internalization of nanobot: It means the nanorobot is driven into the blood cell to repair or supply any substance carefully to targeted particular individual cells, without harming other cell organelles. A microfluidic device is developed to capture a single cell and successfully internalized the nanobot into the cell in order to achieve on-chip internalization. Furthermore, the nanobot was accelerated to 0.35 m/s inside a cell. This finding shows that the intracellular nanobot's internalization can be controlled on the chip. Its surface could be changed with a variety of chemicals and biomolecules. It could be a potential way for driving within a single cell and energizing its organelles [25].

Data mining: It is a computer science subfield that is interdisciplinary. It is the process of extracting information from a data source and transforming it into a structure that can be understood and used. Sales/marketing, banking/finance, healthcare insurance, transportation, and medicine are some of the industries that use data mining. Nanorobots would be a structure capable of nanoscale information processing. A better technique to read and write data on these nanorobots is to use integrated sensors for data transfer. To launch waves and determine the present status of



nanorobots, an electromagnetic reader is used. The wave propagation generated by the emitting device is converted by the nanorobots monitoring data using a well-defined protocol. Information can be reflected by waves resonance based on the latest set of events stored in pattern arrays. Data transmission ranges of 4.5k Hz frequency with roughly 22 μ s latency are conceivable for nanorobot passive data transfer [26].

Wound healing: For detecting and mending wounds, the human body contains a variety of processes and biological triggers. However, when the wound is bleeding profusely or there aren't enough localized coagulant substances in the target site, these biological mechanisms may fall short. Medical micro/nanorobotics aspire to mimic such systems by employing active delivery in the pursuit of quick and effective wound healing. The delivery of thrombin to stop the bleeding of wounds in the vasculature of mouse and pig models has been described using chemically propelled calcium carbonate-based microrobots. A mix of lateral propulsion, buoyant rise, and convection was used in the distribution mechanism. Another method described was the employment of locomotive microrobots for laser-based wound closure. The high temperature generated by the laser-microrobot contact caused localized collagen denaturation and melting, which was followed by condensation and wound closure as the temperature dropped [26].

IX. CONCLUSION

It can be concluded that the Nanorobotics have come far way updating it. There are already many purposes Nanorobotics being used for, as many have been mentioned in this paper. Yet, there are researches going on build much scope in this field. This can be used to overcome disadvantages faced currently.

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