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Nano-Robots as Guards Achieving Anti-Hiv

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***Abstract* – Nanorobotics is the technology of creating machines or robots close to the micro scale of nanometres (10-9 meters), 100 times lesser than the size of an animal cell and hence it can easily monitor the behaviour of cell inside the body at atomic, molecular and cellular level, maintaining and protecting the human body against pathogens in the bio-medical/health sector.**

Nanorobots are to likely be constructed of carbon atoms, generally in diamond structure because of inert properties and strength, glucose (or) natural body sugars and oxygen might be source at propulsion and power. Reduction of device-size also ensures its application in the treatment of AIDS. There is no specific technology for the treatment of AIDS. Some of the drugs of specific composition are given nowadays which increase their lifetime to a few years only. To make the treatment more specific, we use the Nanodevices that use Nano bio-sensor holding Ab for the Ag gp41 & gp120(HIV Ag) will be tagged on its surface. So, whenever it comes in contact of an infected cell the Ab will react with that by an immunochemical reaction and will identify infected cell. Nanochip will receive the signal from sensor and will perform its job. Nanotube, on receiving positive signal gets injected into the nucleus of the cell by nanochip. Nanocontainer will contain highly concentrated DNase and RNase enzyme which will be delivered into the infected cell and will cleave the whole genomic DNA into single nucleotides. Nanorobots will respond to Acoustic signals. So, Nano-robots streaming in blood accumulate there and perform exponentially to kill the infected cell. Thus, Virulency is lost and AIDS infected WBC's is converted back into original WBCs. By doing so, constant levels of WBC's are maintained in the blood stream. It operates at specific sites and has no side effects. Thus, the AIDS patient is provided with an immune system so that he can defend himself from diseases. In future, it is also believed that there is possibility to connect these nanorobots over internet to know the progress of the treatment, so that the killer disease AIDS could also be made in control in the hands of Human with the emerging new Nano- technology & Computer Science.

Keywords: Nanorobots, Anti-HIV, Ag gp41 & 120, Nano bio-sensor, Nano-chip, DNase, RNase, Virulency, Acoustic signal Transmission.

INTRODUCTION

A. Nanorobots

Nanorobotics is the technology of creating machines or robots at or close to the microscopic scale of nanometres (10-9meters). Nanorobots would be typically devices ranging in size from 0.1-10 micrometres, they could work at atomic, molecular and cellular level. Nanorobots are to likely be constructed of carbon atoms, generally in diamond structure because of inert properties and strength, glucose (or) natural body sugars and oxygen might be source at propulsion, Nanorobots will respond to acoustic signals.

B. HIV

HIV stands for Human Immunodeficiency Virus. Like all viruses, HIV cannot grow or reproduce on its own. In order to make new copies of itself, it must infect the cells of a living organism. HIV belongs to a special class of viruses called retroviruses. Within this class, HIV is placed in the subgroup of lent viruses. Outside of a human cell, HIV exists as roughly spherical particles (sometimes called virions). The surface of each particle is studded with lots of little spikes. An HIV particle is around 100-150 billionths of a meter in diameter. That's about the same as: 0.1 microns, one twentieth of the length of an E. coli bacterium, one seventieth of the diameter of a human CD4+ white blood cell. Unlike most bacteria, HIV particles are much too small to be seen through an ordinary microscope. However, they can be seen clearly with an electron microscope as shown in (Fig.1). Our Immune system comprises of two types of cells viz., T-cells, B-cells

B-cells

B-cells responsible for production of antibodies. The principal functions of B cells are to make antibodies against antigens, perform the role of Antigen Presenting Cells (APCs) and eventually develop into memory B cells after activation by antigen interaction. B cells are an essential component of the adaptive immune system.

T-cells

T-cells are two types, either for helping B-cells or for killing damaged cells. Helper T-cells(Th2). Cytotoxic T-cells. (Th for B-cell to do its job requires helper Th2 cell, for cytotoxic T-cell it requires Th1 helper T-cell, when foreign substance enters both B&T cells responds, if foreign agent enters a cell & remain stayed cytotoxic T-

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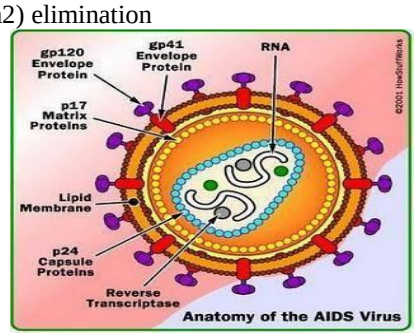
cells are activated & kills that agent. HIV aims at (Th1&Th2) elimination



III. OPERATION OF HIV

Proteins are part of the envelope of HIV, a protein named GP120 recognizes a protein on helper T-cells named CD4, the CD4 protein is a normal part of helper T-cells, HIV infects mainly B&T-cells, Without Immune responses from T-cells, B-cells cannot make antibodies to fight HIV cells. This cycle increases substantial loss of helper T-cells. Our body responds through protection of more T-cells, HIV viruses infects target and eliminate them too. More T-cells produce more infected HIV cells this fight continuous up to inability to produce T-cell.

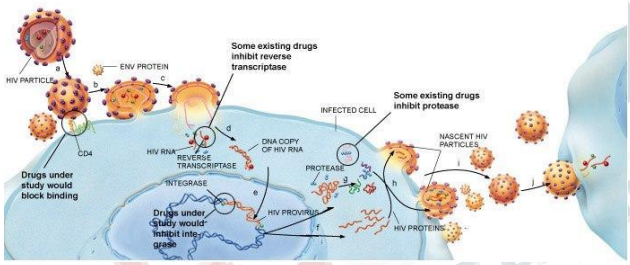


Fig.2 -Operation of HIV Infected cells on T-lymphocytes

IV. HIV LIFE CYCLE

Fig.3- HIV-Infected cells identification

Entry

HIV can only replicate (make new copies of itself) inside human cells. The process typically begins when a virus particle bumps into a cell that carries on its surface a special protein called CD4. The spikes on the surface of the virus particle stick to the CD4 and allow the viral envelope to fuse with the cell membrane. It is done by two unique HIV envelope protein called gp41 and gp120. Gp120 binds with CD4 and then gp41 comes and facilitates the entry of the virus into the host. After the viral entry the viral protein gp41 and gp120 is found in the cell membrane of the infected cell. The contents of the HIV particle are then released into the cell, leaving the envelope behind.

Reverse Transcription and Integration

Once inside the cell, the HIV enzyme reverse transcriptase converts the viral RNA into DNA, which is compatible with human genetic material. This DNA is transported to the cell's nucleus, where it is spliced into the human DNA by the HIV enzyme integrase. Once integrated, the HIV DNA is otherwise known as provirus.

Transcription and Translation

HIV provirus may lie dormant within a cell for a long time. But when the cell becomes activated, it treats HIV genes in much the same way as human genes. First it converts them into messenger RNA (using human enzymes). Then the messenger RNA is transported outside the nucleus and is used as a blueprint for producing new HIV proteins and enzymes.

Assembly, Budding and Maturation

Among the strands of messenger RNA produced by the cell are complete copies of HIV genetic material. These gather together with newly made HIV proteins and enzymes to form new viral particles, which are then released from the cell. The enzyme protease plays a vital role at this stage of the HIV life cycle by chopping up long strands of protein into smaller pieces, which are used to construct mature viral cores. The newly matured HIV particles are ready to infect another cell and begin the replication process all over again. For the viral infection integration of viral genome in the host genome is necessary and in case of all infected cell the unique viral envelope protein will be present on the cell membrane. This viral protein can be used to identify the infected cell and this job will be done by nanorobot.

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V. THE LATEST DRUG USED AGAINST HIV

Zidovudine is the latest known drug that is used for treatment of aids. This drug has an affinity to the HIV genome (RNA molecule) and they bind to it before reverse transcriptase starts working and as a result DNA cannot be synthesized. But any time this drug can lose its efficiency as mutation , results in the reduction of affinity of Zidovudine towards viral genome and as a result RT will start its action and viral genome will be replicated and integrate with host genome.

VI. TREATMENT OF AIDS BY NANOROBOTS

Zidovudine can be used to resist the HIV but the virus cannot be destroyed. Destruction of viral genome is possible by using nanorobots. This type of nanorobots will consists of a nano-biosensor developed by nanoelectronics engineers, a data converter, and a container containing high concentration (say 20 u/microlitre) of DNase and RNase enzyme.

VII. REASONS FOR APPLYING NANOTECH TO BIOLOGICAL SYSTEM

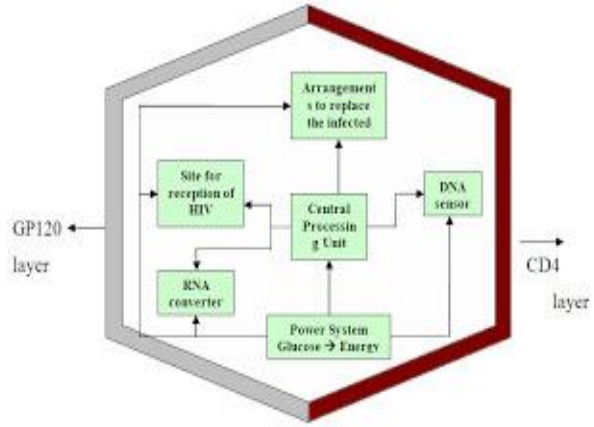
Most animal cells are 10,000 to 20,000 nanometres in diameter. This means that nanoscale devices (having at least one dimension less than 100 nanometres) can enter cells and the organelles inside them to interact with DNA and proteins. Tools developed through nanotechnology may be able to detect disease in a very small amount of cells or tissue. They may also be able to enter and monitor cells within a living body. Nanotechnology could make it possible to run many diagnostic tests simultaneously as well as with more sensitivity. In general, nanotechnology may offer a faster and more efficient means for us to do much of what we do now.

VIII. STUCTURE OF NANOROBOTS

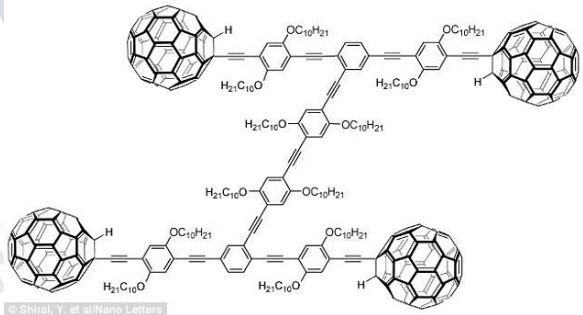
It will be of diamond shape vacuum environment made of carbon derivatives into which matters cannot enter unless need for analysis, it will be subjected to various chemical liquid in our body. The Nanorobots Consists of three main parts

• DNA sensor,
• CPU,
. RNA converter,
. The Power system

Fig.4- Structure of a nanorobot



The purpose of DNA sensor is to identify the HIV infected cell.
RNA converter is used to change the RNA of the HIV.
CPU controls all the activities.
Power system provides necessary energy for the working of the Nanorobots



Scientists developing nano-machines have created capsules of DNA that can change their shape in response to certain conditions in the body and a molecular 'car' that uses balls of carbon as wheels

DNA SENSOR

DNA sensor is cantilever type. In one arm actual sample is placed and in second arm sample of WBC is placed.If sample differ, the sensor identifies. This is the added advantage here.

ACQUIRING POWER

It could metabolize local glucose & oxygen for energy. Another possibility external supplied acoustic power, which is more probably applicable in clinical setting.

COMMUNICATION & TRACKING

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It is essential for us to monitor the work of Nanorobots inside our body, one of a way to communicate is to send message into our body in acoustic messaging, a device similar to ultra sound probe would be employed for the encoding and decoding of the messages.

A navigational network may be installed in the body, with the station and physical positions can be reported continuously using an in vivo communications network.
One of the most interesting applications is the controlled release of drugs over time and exactly localized in cells or organs that need it, drastically reducing the side effects. Nanotechnology is already used in the field of diagnostics through the usage of synthetic tracer molecules for investigating biological processes in a non-invasive fashion.

Nanorobots could be introduced into the body without causing injury and, if equipped with sensors that transmit precise images could facilitate the early diagnosis of HIV and carry drug to the target or to perform other tasks. In order to prevent attacks from immune system a nanorobot in vivo should be characterized with a smooth and flawless diamond exterior, because this prevents Ieukocytes activities since the exterior is chemically inert and have low bioactivity.Below are some algorithm for the movement, process and communication for nanorobots within blood stream inside our body.

Lewis Algorithm

Each μ − robot is able to mark its surrounding through chemical substances, recognizes the different chemical signals and follows the different gradients until it reaches the target cells. The colony is injected close to the target. Once injected into the body, the μ- robots move randomly until they reach target cells. After the first contact the μ-robot emits a substance in its surrounding called CHEM-1. This substance is absorbed by the body after a certain time. A certain percentage of μ − robots differentiate in guidepost, stop and start to secrete substances that permit the transmission of the signal over long distances. These substances are CHEM-2 and CHEM-3 and are used as repeaters. The number of μ−robots that differentiate in guideposts determines the efficiency, which is the convergence of μ − robots to defeat the target. The number of guideposts is very important. In fact, if too many nanobots differentiate it is difficult to reach and destroy the target. On the other hand, if the number of guideposts is too low, the colony is not able to complete the task. For this reason, authors considered a differentiation probability p = 0.01 and related the total number of guideposts to the total number of μ − robots n and the current time t, pnt. In what follows we show the pseudo-code of the Lewis-Bekey approach:_

Algorithm 1: Lewis & Bekey Algorithm
IF There is no chemical Markers and No Tumor
THEN Do a random Walk
IF A Tumor is detected
THEN Destroy the cell, Differentiate and Broadcast CHEM-1; w/prob 1
IF The Mag. of CHEM-1 is greater than Θ THEN Do a random Walk
IF CHEM-1 is detected
THEN Move up the gradient of CHEM-1; w/prob p or differentiate & Broadcast CHEM-2; w/prob(1-p)
IF CHEM-2 is detected
THEN Move up the gradient of CHEM-2; w/prob p or Differentiate & broadcast CHEM-3; w/prob(1-p)
IF CHEM-3 is detected
THEN Move up the gradient of CHEM-2; w/prob 1

Bee's approach

The acoustic communication we propose in this work is inspired from bee's exploration technique for food searching. In practice, our nanobots borrow from the bees the capabilities to communicate through vibration (waggle dance for the bees). The self-organization of the bees is based on very simple rules related to the behaviour of each individual. Moreover, the concept of swarm applied in the context of in vivo application has several advantages compared to isolated nanobot. For example, acoustical nanobots could form in vivo communication networks that could transfer data across much larger distance than possible with direct transmission by considering the attenuation at high frequencies. Generally, nanorobots can improve their performance and they are able to accomplish complex tasks, by coordinating their actions in a decentralized fashion. We refer to this bees' inspired technique as NanoBee and is supported by the possibility of using acoustic waves as transmission means in communications in vivo without specific risks associated to.The vibrations associated to the devices generate acoustic waves that propagate in an elastic medium and cause pressure variations and movement of the particles that compose the medium and that can be perceived and detected from an acoustic detector. This perturbation, that carries both the information and the energy, propagates while every particle, also in the case of a fluid, remains nearby its original position. From a computational point of view, our devices are very simple

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since the algorithm only requires that each device has capabilities of: – recognition of a cancer cell; – destruction of a cancer cell; – emission of vibrations to signal the position of the cancer; – detection of acoustic waves.

Algorithm 2 NanoBee
Repeat
for each "active" nanobot i: pick up any sound signal in its surrounding;
IF there are not any signal/cancer cells search randomly;
IF discovered a cancer cell
THEN eliminate the cell and starts to dancing;
IF a signal has been received
THEN moves towards the higher intensity of the signal;
Until there is an "active" nanobot

Note: Researchers also concentrate on practicing Front crawling motion & Swarming intelligence (advanced part of AI) on the nanorobots models developed to swim and communicate better

BASIC EQUATION OF CONVERSION RATE

The HIV convert the WBC in a faster manner. So, the conversion by the A-HIV nanorobots should also be very much faster than that of the HIV, so that a constant level of WBCs are maintained in the blood stream. So, an AIDS patient can defend himself from various diseases. The conversion rate should be atleast, five times greater than that of HIV. This job should be achieved by the researchers/doctors monitoring externally.

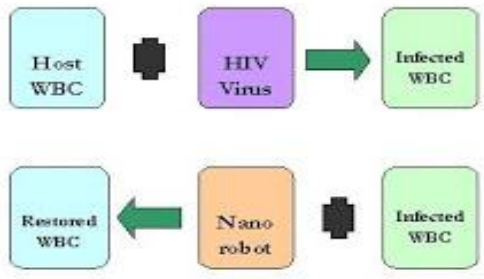

Fig.5- Basic equation of operation

REQUIREMENTS OF NANOROBOTS

It should be very small so that the blood capillary flow is not affected.
It should not be affected by the WBC.
It should convert the infected WBC into the original WBC in a very faster manner.
It should be made of cheaper rates, so that the patient can afford it easily.

IX. COMPONENTS OF AN ANTI-HIV NANOROBOT

A. Nano-biosensor

The Ab for the Ag gp41 & gp120 will be tagged on its surface. So, whenever it will come in contact of an infected cell the Ab will react with that by an immunochemical reaction and will identify this.

B. Nanochip

It's a chip which will receive the signal from nano-biosensor and will perform its job.

C. Nanotube

It's a tube in nanoscale. On receiving +ve signal the nanotube will be injected into the nucleus of the cell by nanochip.

D. Nanocontainer

A nanocontainer will contain highly concentrated DNase and RNase enzyme which will be delivered into the infected cell and will cleave the whole genomic DNA into single nucleotides.

X. PROCESS

The function of the biosensor is to identify a particular compound. In this case the biosensor will contain a particular antibody. The gp41 and gp120 are two unique HIV envelope protein which is found in the cell membrane of the infected cell. The antigen (gp41 and gp120 protein) and antibody reaction will give the proper signal. In case of infected cell only this reaction will take place as those viral proteins are found in the cell membrane of the infected cell only. Getting the +ve signal the nanorobot will inject its nanotube into the nucleus of the infected cell and release the DNase as well as RNase enzyme into the cell. The DNase enzyme is not sequence specific and as a result it will cleave the whole genomic DNA containing the viral genome into single nucleotides. Once the viral genome loses its sequence it loses its viral effect and after the digestion of the whole genomic DNA the cell undergoes normal programmed cell death called apoptosis. Thus the infected cell of the diseased body can be destroyed to finish off the viral genome in the body as shown in (Fig.6).

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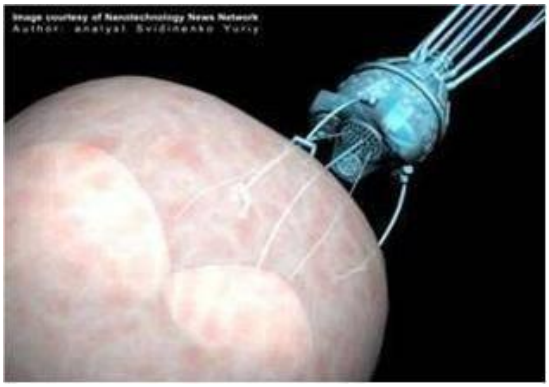

Fig. 6- Nanorobot performing operations on blood cells

XI. ADVANTAGES

More than million people in this world are affected by this dreaded disease. Currently there is no Permanent vaccine or medicine is available to cure the disease. The currently available drugs can Increase the patient's life to a few years only, so the invention of this nanorobot will make the patients to get rid of the disease.

As the nanorobot do not generate any harmful activities there is no side effect. It operates at specific site only.
The initial cost of development is only high but the manufacturing by batch processing reduces the Cost.

XII. DISADVANTAGES

The nanorobot should be very accurate, otherwise harmful effects may occur.
The initial design cost is very high.
The design of this nanorobot is a very complicated one.

XIII.FUTURE SCOPE

A computer inside cockroach – Nano-sized entities made of DNA that are able to perform the same kind of logic operations as a silicon-based computer. The DNA computers – known as origami robots because they work by folding and unfolding strands of DNA – travel around the insect's body and interact with each other, as well as the insect's cells. When they uncurl, they can dispense drugs carried in their folds. "DNA nanorobots could potentially carry out complex programs that could one day be used to diagnose or treat diseases with unprecedented sophistication," says Daniel Levner, a bioengineer at the Wyss Institute at Harvard University.

A computer scientist says nanobots could connect our brains to the Cloud. This allow people to back up their memories and communicate by thought. It could also help to expand human creativity and emotions, he claims. The human brain could be enhanced by tiny robotic implants that connect to cloud-based computer networks to give us 'God-like' abilities, according to a leading computer scientist, Ray Kurzweil, an author and inventor who describes himself as a futurist who works on Google's machine learning project, said such technology could be the next step in human evolution. He predicted that by the 2030s, humans will be using nanobots capable of tapping into our neocortex and connecting us directly to the world around us.

XIV. CONCLUSION

The paper is just a theoretical justification. But the recent advancement in the field of Nanotechnology gives the hope of the effective use of this technology in medical field. This is the beginning of nano era and we could expect further improvements such as a medicine to AIDS using nanotechnology.

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