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LOW DIMENSIONAL SYSTEMS

"NANOROBOTS"

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NANOROBOTS

Nanorobotics is emerging as a demanding field dealing with miniscule things at molecular level, and it is mainly used for medical applications. Nanorobots are nanoelectromechanical systems designed to perform a specific task with precision at nanoscale dimensions. Its advantage over conventional medicine lies on its size.

The design of nanorobots is derived from biological models, specifically in the behaviour of bacteria. The various components in the nanorobot design may include onboard sensors, motors, manipulators, power supplies, and molecular computers.

The idea of introducing small submarines through the blood vessels has been captured in many films. But the blood at nanoscale becomes viscous and sticky fluid which does not let the submarine to drive along the vessels. Another phenomenon that would not let the submarine to travel is the Brownian movement of the molecules; the collisions between molecules are incontrollable and unpredictable.

Nanorobot Control Design (NCD) simulator was developed, which is software for nanorobots in environments with fluids dominated by Brownian motion and viscous rather than inertial forces.

Bacteria travel to the food sources and move away from the areas where they detected dangerous substances. They have a kind of sensors spread through their cellular wall which detect the food and transmit signals to the motors that control the rotation of the flagella. As higher is the concentration of the molecules, the faster the bacteria will travel to the area where the nutrients are. If they found a place with dangerous substances like a salt concentration area, the sensors stop them with the flagella, and change their direction. They made a valance between the positive and negative molecules that they found and if the valance is positive they continue travelling forward, and if it is negative they turn around.

Figure 1: Bacteria

Nanorobots have chemical sensors which detect the target molecules. As a response they would emit a power signal proportional to the detected amount. This signal would arrive to a programmed microprocessor which controls the direction and velocity of the nanorobot. This system would maintain the robot in the pursuit of its objective.

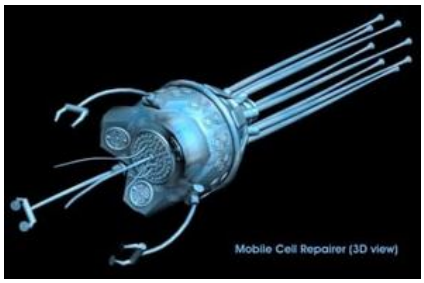

Figure 2: Nanorobot

Nanorobots allow drugs of nanosize to be used in lower concentration and have an earlier onset of therapeutic action. It also provides materials for controlled drug delivery by directing carriers to a specific location.

The nanorobots can be attacked by the host's immune system. To avoid that, the best choice is to have an exterior coating of passive diamond. The smoother and flawless the coating, the lesser is the reaction from the body's immune system.

Nanorobots have many applications, but there are going to be explained the most interested ones.

Cancer Detection and Treatment

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.

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.

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 (O_2) and carbon dioxide (CO_2) 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, O_2 partial pressure is high and CO_2 partial pressure is low, so the onboard computer tells the sorting rotors to load the tanks with oxygen and to dump the CO_2. When CO_2 partial pressure is relatively high and O_2 partial pressure relatively low the onboard computer commands the sorting rotors to release O_2 and to absorb CO_2. 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.

Respirocytes have also some sensors to receive acoustic signals from the doctor who will use some ultrasound-like transmitter to modify the behaviour of the Respirocytes when they are still inside the body of the patient.

Artificial Phagocytes – Microbivores Nanorobots

The primary function of a Microbivore is to destroy microbiological pathogens found in the human bloodstream. They could patrol the bloodstream, seeking out and digesting unwanted pathogens including bacteria, viruses, or fungi. Given intravenously

they would achieve complete disappearance of even the most severe septicemic infections in hours or less. This is much better than the weeks or months needed for antibiotic-assisted natural phagocytic defenses.

Chromallocyte: A Hypothetical Mobile Cell-Repair Nanorobot

Another nanorobot, 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, a repair machine will first size up the situation by examining the cell's contents and activity, and then take action. They would be able to repair whole cells, organs, and restore health.