Nano-Robotics in Medical Applications-Ventilons

J. Thirumaran, S. Dhinakaran

Abstract: Nano Robotics is a field under continuous development. It involves the construction of robots of the size of 10^-9m. In the last decade many nano robots have made their way out of the drawing boards to enter into the human body and do things beyond human imagination. Symptoms like itching and fever have certain biochemical causes which can be eliminated by injecting nano robots. In this technological era of development our paper acts as a beacon for scientists and research scholars. Our paper mainly concentrates on creating nano robots that mimic the action of RBC's. These nano robots are called as Ventilons. Our paper also concentrates on future trends of nano robotics like implementing nano robots to detect human physiology. The second part of our paper deals with introducing nanosensors and nano-robots in detecting Human blood sugar level. These nano-robots are embedded with mobile phones and the status of the patient can be read from remote places. These nano particles that reduce the size of microelectronic components will cover the entire world inside a single chip.

Keywords: nano-robots, nano sensors, ventilons, nano technology, nano-medicine

I. INTRODUCTION

The term "nanotechnology" generally refers to designed engineering and manufacturing at the molecular or nanometre length scale. (A nanometre is one-billionth of a meter, about the width of 6 bonded carbon atoms.) . Nanotechnology has given us specially engineered drugs called nanoscale cancer-seeking missiles, a molecular technology that specifically targets just the mutant cancer cells in the human body, and leaves rest of things blissfully alone. To do this, these drug molecules will have to be big enough – thousands of atoms – so that we can code the information into them regarding where they should go and what they should destroy. They will be examples of an exquisite, human-made nanotechnology in the future. It is most useful with regard the emerging field of nano-medicine as a set of three mutually overlapping and progressively more powerful technologies. In the relatively near term, at first, nano-medicine can address many important medical problems by using nanoscale-structured materials that can be manufactured today. This includes the interaction of nanostructures materials with biological systems. Second, over the next 5-10 years, biotechnology will make things possible even more remarkable developments in molecular medicine and bio-robotics (microbiological robots), some of which are already on the drawing boards. Third, in the longer term, perhaps 10-20 years from today, the earliest molecular machine systems and nano-robots may join the medical armamentarium, finally giving physicians the most potent tools imaginable to conquer human diseases, ill-health, and suffering.

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In broader terms, nano-medicine is the process of diagnosing, treating, and preventing disease and traumatic injury, of relieving pain, and of preserving and improving human health, using molecular tools and molecular knowledge of the human body.

II. MAKING NANO ROBOTS

The typical medical nano-device will probably be a micron-scale robot assembled from nanoscale parts. These parts could range in size from 1-100 nm (1 nm = 10^{-9} meter), and might be fitted together to make a working machine measuring perhaps 0.5-3 microns (1 micron = 10^{-6} meter) in diameter. Three microns is about the maximum size for blood borne medical nano-robots, due to the capillary passage requirement. Carbon will likely be the principal element comprising the bulk of a medical nano-robot, probably in the form of diamond or diamonded/fullerene nano-composites largely because of its tremendous strength and chemical inertness of diamond. Many other lighter elements such as hydrogen, sulphur, oxygen, nitrogen, fluorine, silicon, etc. will be used for special purposes in nanoscale gears and other components.

III. APPEARANCE OF NANO-ROBOTS

It is impossible to say exactly what a generic nano-robot would look like. Nano-robots are intended to travel through the bloodstream to their target will probably be 500-3000 nanometers (1 nanometer = 10-9 meter) in characteristic dimension. Non-blood borne tissue-traversing nano-robots might be as large as 50-100 microns, and alimentary or bronchial-travelling nano-robots may be even larger still. Each species of medical nano-robot will be designed to accomplish a specific task, and many shapes and sizes are possible. In most cases a human patient who is undergoing a nano-medical treatment is going to look just like anyone else who is sick. The typical nano-medical treatment (e.g. to combat a bacterial or viral infection) will consist of an injection of perhaps a few cubic centimetres of micron-sized nano-robots suspended in fluid (probably a water/saline suspension). The typical therapeutic dose may include up to 1-10 trillion (1 trillion = 1012) individual nano-robots, although in some cases treatment may only require a few million or a few billion individual devices to be injected. Each nano-robot will be on the order of perhaps 0.5 micron up to perhaps 3 microns in diameter. (The exact size depends on the design, and on exactly what the nano-robots are intended to do.) The adult human body has a volume of perhaps 100,000 cm^3 and a blood volume of ~5400 cm^3, so adding a mere ~3 cm^3 dose of nano-robots is not particularly invasive. The nano-robots are going to be doing what exactly the doctor tells them to do, and nothing more (barring malfunctions).

So the only physical change you will see in the patient is that he or she will very rapidly become well again. Most symptoms such as fever and itching have specific biochemical causes which can also be managed, reduced, and eliminated using the appropriate injected nano-robots. Major rashes or lesions such as those that occur when you have the measles will take a bit longer to reverse, because in this case the broken skin must also be repaired.

IV. ARTIFICIAL RED CELL

We named this Nano-robot as ventilons. The ventilons measures about 1 micron in diameter and just floats along in the bloodstream. It is a spherical nanorobot made of 18 billion atoms.

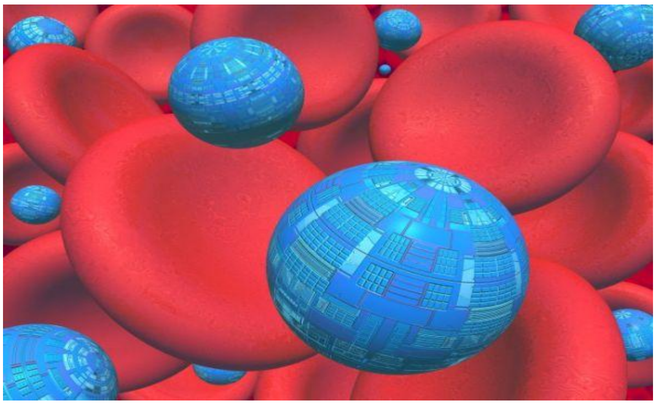

Fig. 1: Ventilons amidst the RBC's

These atoms are mostly carbon atoms arranged as diamond in a porous lattice structure inside the spherical shell. The ventilons is essentially a tiny pressure tank that can be pumped full of up to 9 billion oxygen (O2) and carbon dioxide (CO2) molecules. Later on, these gases can be released from the tiny tank in a controlled manner. The gases are stored onboard at pressures up to about 1000 atmospheres. (Ventilons can be rendered completely nonflammable by constructing the device internally of sapphire, a flame proof material with chemical and mechanical properties otherwise similar to diamond.). The surface of each ventilons is 37% covered with 29,160 molecular sorting rotors that can load and unload gases into the tanks. There are also gas concentration sensors on the outside of each device. When the nano-robot 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 the device later finds itself in the oxygen-starved peripheral tissues, the sensor readings are reversed. That is, CO_2 partial pressure is relatively high and O_2 partial pressure relatively low, so the onboard computer commands the sorting rotors to release O_2 and to absorb CO_2. Ventilons mimic the action of the natural haemoglobin-filled red blood cells. But a ventilons can deliver 236 times more oxygen per unit volume than a natural red cell. This nanorobot is far more efficient than biology, mainly because its diamonded construction which permits a much higher operating pressure. (The operating pressure of the natural red blood cell is the equivalent of only about 0.51 atm, of which only about 0.13 atm is deliverable to tissues.) So the injection of a 5 cm3 dose of 50% ventilons aqueous suspension into the bloodstream can exactly replace the entire O2 and CO2 carrying capacity of the patient's entire 5,400 cm3 of blood! Ventilons will have pressure sensors to receive acoustic signals from the doctor, who will use an ultrasound-like transmitter device to give the ventilons commands to modify their behaviour while they are still inside the patient's body. For example, the doctor might order all the ventilons to just stop pumping, and become dormant. Later, the doctor might order them all to turn on again.

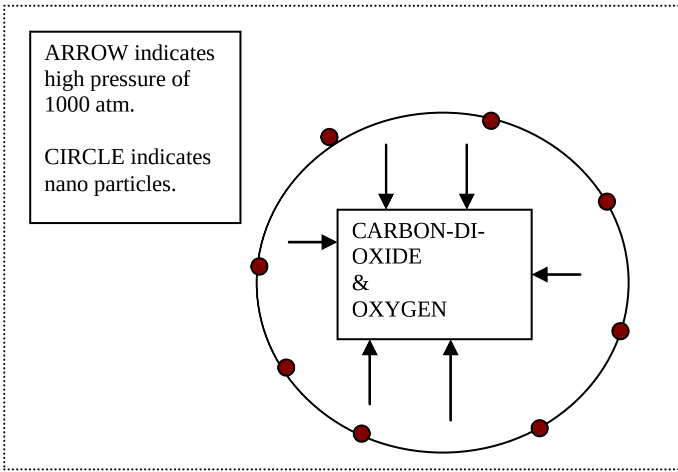

Fig. 2: Action of Ventilon

V. APPLICATIONS

By adding 5ml of Ventilons into our bloodstream, we could then hold our breath for nearly 4 hours on sitting quietly at the bottom of a swimming pool. Or if we were sprinting at top speed, we could run for at least 15 minutes before we had to take a breath!

These Ventilons can also be used by scuba divers and Navy for underwater diving. Even Astronauts can use this because Ventilons is not affected by outer space activities as blood flow is always active. In both cases the users need to carry only pocket sized oxygen tanks and breath for many hours. It is clear that very "simple" medical nanodevice can have extremely useful abilities, even when applied in relatively small doses. They will have different types of robotic manipulators, different sensor arrays and so forth. Each medical nanorobot will be designed to do a particular job extremely well, and will have a unique shape and behavior.

VI. NANOSYSTEM TO DETECT HUMAN PHSIOLOGY

Currently operate with micron sized active regions and offer the ability to do thousands of measurements individual gene activities. Such arrays will allow hundreds and thousands of human genes to be monitored throughout a mission and will allow the determination of the effects of microgravity on human physiology in ways that are not imagined at present, as well as providing early warning of cancer or other disease states. By determining which genes are activated or inhibited, rack-mounted intelligent medical systems will be able to apply preventative care at the earliest possible point.

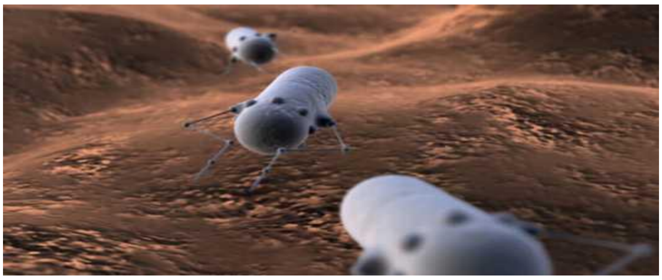

Fig. 3: Nano-robots analysing gene stacks.

As with many advances in nanotechnology, the First difficulty may be in integrating these many different units into functioning systems and interfacing them to the macro real world.

VII. NANOSENSORS IN MOBILE PHONES

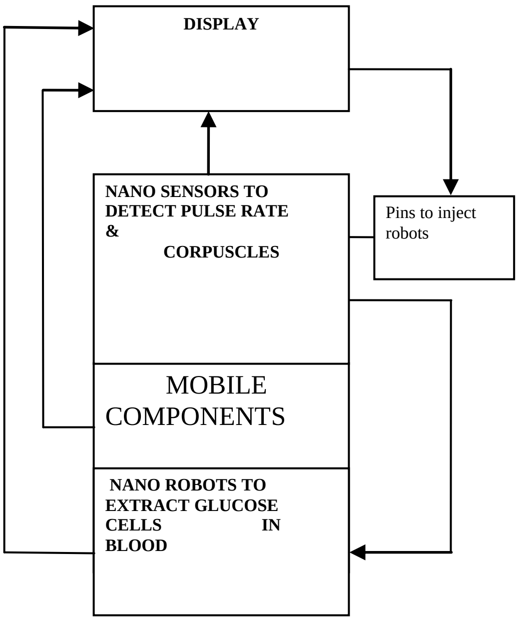

Fig. 4: Nanosensors in mobile phones.

VIII. CONCLUSION

Nano-medicine will eliminate virtually all common diseases of the 20th century, virtually all medical pain and suffering, and allow the extension of human capabilities most especially our mental abilities. Consider that a nanostructures data storage device measuring ~8,000 micron^3, a cubic volume about the size of a single human liver cell and smaller than a typical neuron, could store an amount of information equivalent to the entire Library of Congress. If implanted somewhere in the human brain, together with the appropriate interface mechanisms, such a device could allow extremely rapid access to this information. A single nano-computer CPU, also having the volume of just one tiny human cell, could compute at the rate of 10 teraflops (10^{13} floating-point operations per second), approximately equaling (by many estimates) the computational output of the entire human brain. Such a nano-computer might produce only about 0.001 watt of waste heat, as compared to the ~25 watts of waste heat for the biological brain in which the nano-computer might be embedded. But perhaps the most important long-term benefit to human society as a whole could be the dawning of a new era of peace. We could hope that people who are independently well-fed, well-clothed, well-housed, smart, well-educated, healthy and happy will have little motivation to make war. Human beings who have a reasonable prospect of living many "normal" lifetimes will learn patience from experience, and will be extremely unlikely to risk those "many lifetimes" for any but the most compelling of reason.

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