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REVIEW ARTICLE

NANOTECHNOLOGY USE IN MEDICINE

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HOWTOCITETHISARTICLE:
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ABSTRACT: Technology is shrinking quantity wise, increasing quality wise at a rather rapid rate. As a result, more and more advancements are taking place at the cellular, molecular and atomic level — at the nanoscale. **NANOTECHNOLOGY:** Is especially important to medicine because the medical field deals with things on the smallest of levels. Additionally, the small nano devices that are being developed right now can enter the body and treat and prevent diseases. **NANOMEDICINE:** Is the application of nanotechnology (the engineering of tiny machines) for the prevention and treatment of disease in the human body. This evolving discipline has the potential to dramatically change medical science. **NANOBOTS:** Smallest of robots could be used to perform a number of functions inside the body and out. They could even be programmed to build other nanobots. **NANOCOMPUTERS:** To direct nanobots in their work, there are special computers. **NANOTWEEZERS:** devices are designed to manipulate nanostructures. Nanotweezers are usually constructed using nanotubes. **NANOCHIP:** Is an integrated circuit that is so small, in physical terms, that individual particles of matter play major roles

KEYWORDS: Nanotechnology, Nanomedicine,Nanobots, Nanocomputers, Nanotweezers, Nanochip.

INTRODUCTION: Nanomedicine 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. [1,2]

"Nanomedicine is the preservation and improvement of human health using molecular tools and molecular knowledge of the human body". [3,4]

Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering.[3]

Nanotechnology can best be defined as a description of activities at the level of atoms and molecules that have applications in the real world. A nanometer is a billionth of a meter, that is, about 1/80,000 of the diameter of a human hair, or 10 times the diameter of a hydrogen atom.[5]

Nanotechnology is especially important to medicine because the medical field deals with things on the smallest of levels. Additionally, the small nano devices that are being developed right now can enter the body and look around in ways that large humans can only dream of.[6]

This evolving discipline has the potential to dramatically change medical science. Established and near-future nanomedicine applications include activity monitors, chemotherapy, pacemakers, biochips, OTC tests, insulin pumps, nebulizers, needleless injectors, hearing aids, medical flow sensors and blood pressure, glucose monitoring and drug delivery systems.[7]

Here are a few examples of how nanomedicine could transform common medical Procedures:

- Diagnostic nanomachines could be employed to monitor the internal chemistry of the body. Mobile nanorobots, equipped with wireless transmitters, could circulate in the blood and lymph systems, and send out warnings when chemical imbalances occur or worsen.

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- Similar fixed nanomachines could be planted in the nervous system to monitor pulse, brain-wave activity, and other functions.
- Implanted nanotechnology devices could dispense drugs or hormones as needed in people with chronic imbalance or deficiency states. In heart defibrillators and pacemakers, nanomachines could affect the behaviour of individual cells.
- Artificial antibodies, artificial white and red blood cells, and antiviral nanorobots.[7]

The most advanced nanomedicine involves the use of nanobots as miniature surgeons. Such machines might repair damaged cells, or get inside cells and replace or assist damaged intracellular structures. At the extreme, nanomachines might replicate themselves, or correct genetic deficiencies by altering or replacing DNA molecules.[8]

What would be the biggest benefit to be gained for human society from nanomedicine?

Nanomedicine 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.[9]

Holds promise in the quest for ever-more-powerful computers and communications devices. But the most fascinating (and potentially dangerous) applications are in medical science. So-called nanorobots might serve as programmable antibodies. As disease-causing bacteria and viruses mutate in their endless attempts to get around medical treatments, nanorobots could be reprogrammed to selectively seek out and destroy them. Other nanorobots might be programmed to single out and kill cancer cells.[9]

Two concepts associated with nanotechnology are positional assembly and self-replication. Molecular robots are devices that do the positional assembly. Self-replication deals with the problem of multiplying the positional arrangements in some automatic way, both in building 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. [9]

PRESENT MEDICAL CHALLENGES [9]:

- Aging.
- Arteriosclerosis.
- Artificial Blood and Respiration.
- Augmentation.
- Bacterial Infection.
- Cancer.
- Cosmetics and Hair Care.
- Cryostasis.
- Dental Care.
- Diagnosis and Testing.
- Emergency Care and Trauma.
- Gene Therapy.
- Neurological Damage.
- Thrombosis.

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NANOTECHNOLOGY TECHNICAL TOOLS:

NANOBOTS: These devices have great potential for medical uses. These smallest of robots could be used to perform a number of functions inside the body and out. They could even be programmed to build other nanobots. [10]

NANOCOMPUTERS: A computer with circuitry so small that it can only be seen through a microscope. Nanocomputers can be electronic (where nanolithography is used to create microscopic circuits), biochemical or organic (such as DNA computers), or quantum (Such as quantum computers). Nanocomputers deal with materials at a molecular level and hold the promise of creating increasingly smaller and faster computers, an important concept in the realm of pervasive computing used to direct nanobots in their work. [11]

NANOTWEEZERS: Nanoscale electromechanical systems—nanotweezers—based on carbon nano-tubes have been developed for manipulation and interrogation of nanostructures. These can be used to move nano devices around in the body, or position them prior to insertion.[12]

NANOCHIP: IS an integrated circuit (IC) that is so small, in physical terms, that individual particles of matter play major roles for controlling nanobots. [13]

USE OF NANOBOTS IN MEDICINE. [6,14]

CELL REPAIR: Damage to the cells of the body can be very difficult to repair. But nanotechnology could provide a way to get around this. Small nanobots or other devices could be used to manipulate molecules and atoms on an individual level, repairing cells.

CANCER TREATMENT: There are hopes that the use of nanotechnology could help in cancer treatment. This is because the small, specialized functions of some nano devices could be directed more precisely at cancer cells. Current technology damages the healthy cells surrounding cancer cells, as well as destroying the undesirables. With nanotechnology, it is possible that cancer cells could be targeted and destroyed with almost no damage to surrounding healthy tissue.

AGING: Nano devices could be used to erase some of the signs of aging. Already, laser technology can reduce the appearance of age lines, spots and wrinkles. With the help of powerful nanotechnology, it is possible that these signs could be done away with completely.

HEART DISEASE: There is a possibility that nanobots could perform a number of heart related functions in the body. The repair of damaged heart tissue is only one possibility. Another option is to use nano devices to clean out arteries, helping unclog those that have buildup due to cholesterol and other problems.

IMPLANTING DEVICES: Instead of implanting devices as we have seen in some cases, it might be possible to send nanobot to build the necessary structures inside the body.

VIRTUAL REALITY: Doctors could explore the body more readily with the help of a nanobot injection. Creating a virtual reality that would help medical professionals and others learn could help make some operations more “real” and provide practice ahead of time.

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GENE THERAPY: Nanotechnology would be small enough to enter the body and even redesign the genome. This would be a way to alter a number of conditions and diseases. However, nanobots would be qualified for swapping abnormal genes with normal genes and performing other functions.

DRUG DELIVERY: Systems that automate drug delivery can help increase the consistency associated with providing medication to those who need it. Drug delivery systems can be regulated using nanotechnology to ensure that certain types of medications are released at the proper time, and without the human error that comes with forgetting to take something.

STEM CELLS: Nanotechnology can actually help adult stem cells morph into the types of cells that are actually needed. Studies showing how nanotubes can help adult stem cells turn into function neurons in brain damaged rats.

BONE REPAIR: It is possible to accelerate bone repair using nanotechnology. Nanoparticles made up of different chemical compositions can help knit bones back together, and can even help in some cases of spinal cord injury.

IMAGING: Nanotechnology can provide advancements in medical imaging by allowing a very specific and intimate peek into the body. Nano devices result in molecular imaging that can lead to better diagnosis of a variety of diseases and conditions.

DIABETES: Instead of having to draw blood to test blood sugar level, nanotechnology is providing a way for diabetics to use lenses to check their blood sugar. These nanocomposite contact lenses actually change color to indicate blood sugar level.

SURGERY: We already have robotic surgeons in some cases, but nanosurgery is possible using some lasers, as well as nano devices that can be programmed to perform some surgical functions. Being able to perform surgery at the smallest level can have a number of benefits for long term medicine.

SEIZURES: There are nanochips being developed to help control seizures. These chips are meant to analyze brain signals, and then do what is needed to adjust the brain so that epilepsy could be better controlled.

SENSORY FEEDBACK: For those who have lost feeling in their body, it is possible to use nanotechnology to increase sensory feedback. Nanochips provide the opportunity for electrical impulses to be intercepted and interpreted.

LIMB CONTROL: Prosthetics continue to advance, and nanotechnology is likely to help revolutionize the way paralysis is handled. There are some attempts to use nanochips that can help those who have lost limb control use their minds to send signals to provide a certain amount of motion.

DISEASE PREVENTION: Having a nano device in your body could actually help prevent diseases. With proper programming, it should be possible to help you avoid some diseases, repairing problems before they become serious issues. They may even be able to help prevent chronic diseases.

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PRENATAL: There are a number of ways that nanotechnology can help in terms of prenatal diagnosis. Being able to get inside the uterus and even inside the fetus without causing trauma can be beneficial to prenatal health, and nanotechnology can also help potentially repair problems in the womb.

INDIVIDUAL MEDICINE: Nanotechnology is moving toward making medicine more personal. Being able to accurately work up your genome can help health providers more precisely pinpoint the proper treatments and tweak a treatment plan according to your individual needs and responses.

MEDICAL MONITORING: You might be able to increase your ability to monitor your own body systems with the help of nanotechnology. Small nanochips implanted in your body could monitor your health and systems, and then send you feedback to your computer or other device.

MEDICAL RECORDS: In addition to monitoring your own body systems, nanotech can be used to send information to your health care providers, and increase the efficiency of electronic medical records.

RESEARCH: Nanotechnology is advancing medical research, providing the tools that can help us learn more about the body and how it functions, as well as providing insight into chemistry and physics, which provide the building blocks for the body.

TECHNICAL ANALYSES OF TYPES OF DIAMONDOID MEDICAL NANOROBOTS:

RESPIROCYTES: (Artificial mechanical red cells) [15] Microbivores (Artificial mechanical white cells)[16] Clottocytes (artificial mechanical platelets)[17] Pharmacytes (ideal drug delivery nanorobot)[18] Dentifrobots (and other dental nanorobots;)[19] Vasculoid (complete artificial vasculature)[20] Programmable Dermal Display (comprehensive real-time personal medical monitoring system)[21] Chromallocytes (chromosome exchange therapy). [22]

The respirocyte is a simple nanotechnological device (Artificial red cell) whose primary applications include transfusable blood substitution; treatment for anaemia, perinatal and neonatal disorders, and a variety of lung diseases and conditions; contribution to the success of certain aggressive cardiovascular and neurovascular procedures, tumour therapies and diagnostics; prevention of asphyxia; maintenance of artificial breathing in adverse environments; and a variety of sports, veterinary, battlefield and other applications.

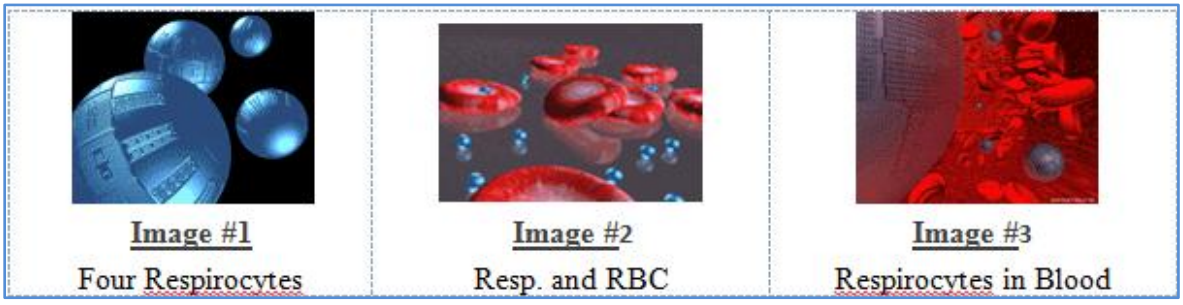

Image #1
Four Respirocytes

Image #2
Resp. and RBC

Image #3
Respirocytes in Blood

RESPIROCYTES: (Artificial mechanical red cells)[15]

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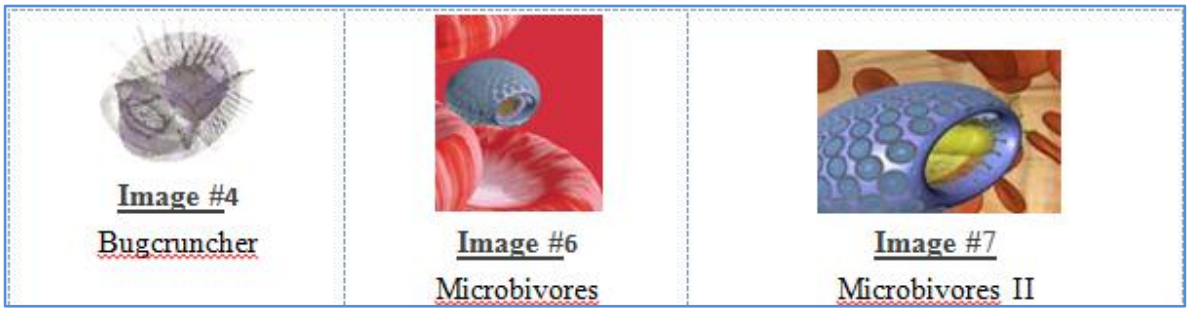
Respirocytes an artificial erythrocyte, duplicating the oxygen and carbon dioxide transport functions of red cells while largely eliminating the need to manage carbonic acidity, can deliver 236 times more oxygen to the tissues per unit volume than natural red cells, and enjoys a similar advantage in carbon dioxide transport, may find dozens of applications in therapeutic and critical care medicine, and elsewhere.

MICROBIVORES:

1. Microbivores would mimic white cells and perform phagocytosis of specific bacteria, viruses or fungi.[23]



2. The microbivore consisting of sufficient mechanical mincing power, digestion chamber where a pre-programmed sequence of engineered enzymes are successively injected and extracted, reducing the morcellate primarily to monoresidue amino acids, mononucleotides, glycerol, free fatty acids and simple sugars, which are then harmlessly discharged into the environment, completing the cycle.
3. The microbivores could thus be the future answer to rapidly evolving antibiotic resistance, especially in the ICUs.

CLOTTOCYTES[18]: The artificial mechanical blood platelet or Clottocyte may allow complete haemostasis in as little as ~1 second, even in moderately large wounds. This response time is on the order of 100-1000 times faster than the natural system. The baseline Clottocyte, designed by Robert A. Freitas Jr., is conceived as a serum oxyglucose-powered spherical nanorobot ~2 microns in diameter (~4 micron 3 volume) containing a compactly-folded biodegradable fiber mesh. Upon command from its control computer, the device promptly unfurls its mesh packet in the immediate vicinity of an injured blood vessel – following, say, a cut through the skin. Soluble thin films coating certain parts of the mesh dissolve upon contact with plasma water, revealing sticky sections (e.g., complementary to blood group antigens unique to red cell surfaces) in desired patterns. Blood cells are immediately trapped in the overlapping artificial nettings released by multiple neighboring activated clottocytes, and bleeding halts at once. Hence clottocytes appear to be about 10,000 times more effective as clotting agents than an equal volume of natural platelets.

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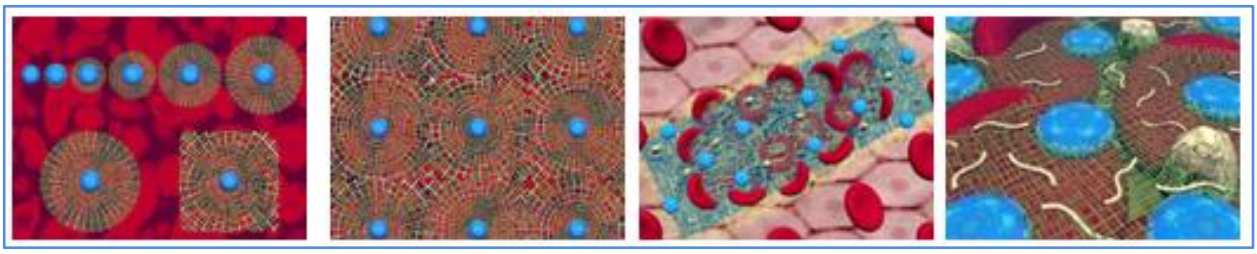

Figure 1: Clottocytes at work

VASCULOCYTE[13]: The vasculocyte, intended for use in the limited vascular repair of primarily intimal arteriosclerotic lesions, cycling allows a nanorobot situated on an arterial wall to continuously adjust its girth by up to 15% to match the regular distensions of arterial wall circumference that occur during each systolic pulse of the heart.

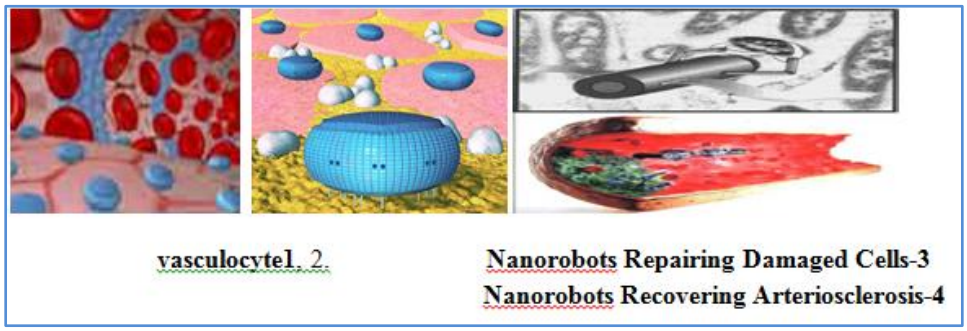

Figure 2

VASCULOID: Vasculoid is a single, complex, multi-segmented nanotechnological medical robotic system capable of all transport functions of the blood, including circulation of respiratory gases, glucose, hormones, cytokines, waste products and cellular components. This nanorobotic system could substitute the human vascular system. The Vasculoid system conforms to the shape of existing blood vessels and serves as a complete replacement for natural blood.

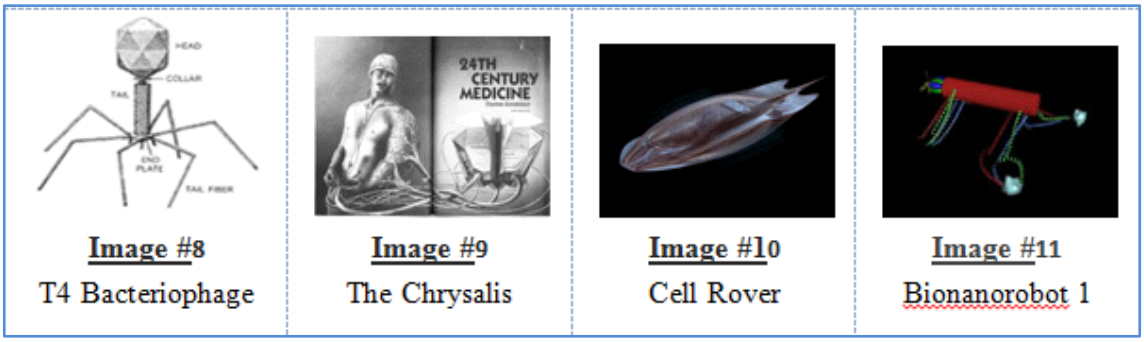

Image #8
T4 Bacteriophage

Image #9
The Chrysalis

Image #10
Cell Rover

Image #11
Bionanorobot 1

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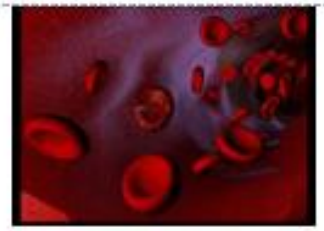

Image #12
Bionanorobot 2

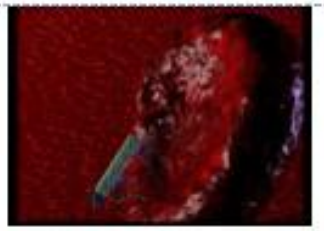

Image #13
Bionanorobot 3

PHARMACYTES: An ideal vehicle for targeted drug delivery. Freitas RA Jr. An ideal nanotechnology-based drug delivery system is a pharmacyte-a self-powered.[24]

The nanoscale drug delivery system is a multi-stage technique. Nanocarriers 100 times smaller than a strand of hair are guided through the blood system to diseased cells. Once they reach the cells, they release diagnostic agents, medicine, or both. In the first stage of the approach, nanocarriers go to the inner wall of blood vessels, near the unwanted cells. As those nanocarriers degrade they release a second stage of more tiny nanoparticles that can penetrate the blood vessel wall to get inside the diseased cells. The third stage of the system involves the release of medications to kill the tumour and other agents that take images of it. The nanocarriers are made of silicon, which is fully biodegradable so it won't injure the body.[25]

DENTIFROBOTS: Medical nanobots capable of repairing the various tissues of the teeth and gums will bring new dimensions to dental care. [26]

Image #14
Dental Nanorobots I

Image #15
Dental Nanorobots II

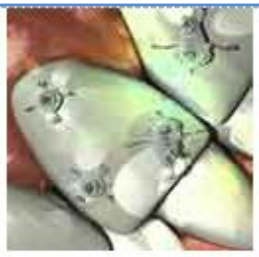

Image #16
Dental Nanorobots III

Image #17
Dental Nanorobots IV

NANODENTISTRY [27]: Nanodentistry will make possible the maintenance of near-perfect oral health through the use of nanornaterials, biotechnology including tissue engineering and nanorobotics. Oral health and disease trends may change the focus on specific diagnostic and treatment modalities. Nanodentistry as the bottom-up approach. [27]

Now bots used as Local anaesthesia,Hypersensitivity cure, Nanorobotic dentifrice [Dentifrobots],a mouthwash or toothpaste Dental durability, cosmetics, Orthodontic treatment, Nanocomposites, Nanosolution -bonding agents. Bone targeting nanocarriers Nano needles and Bone replacement materials. [27]

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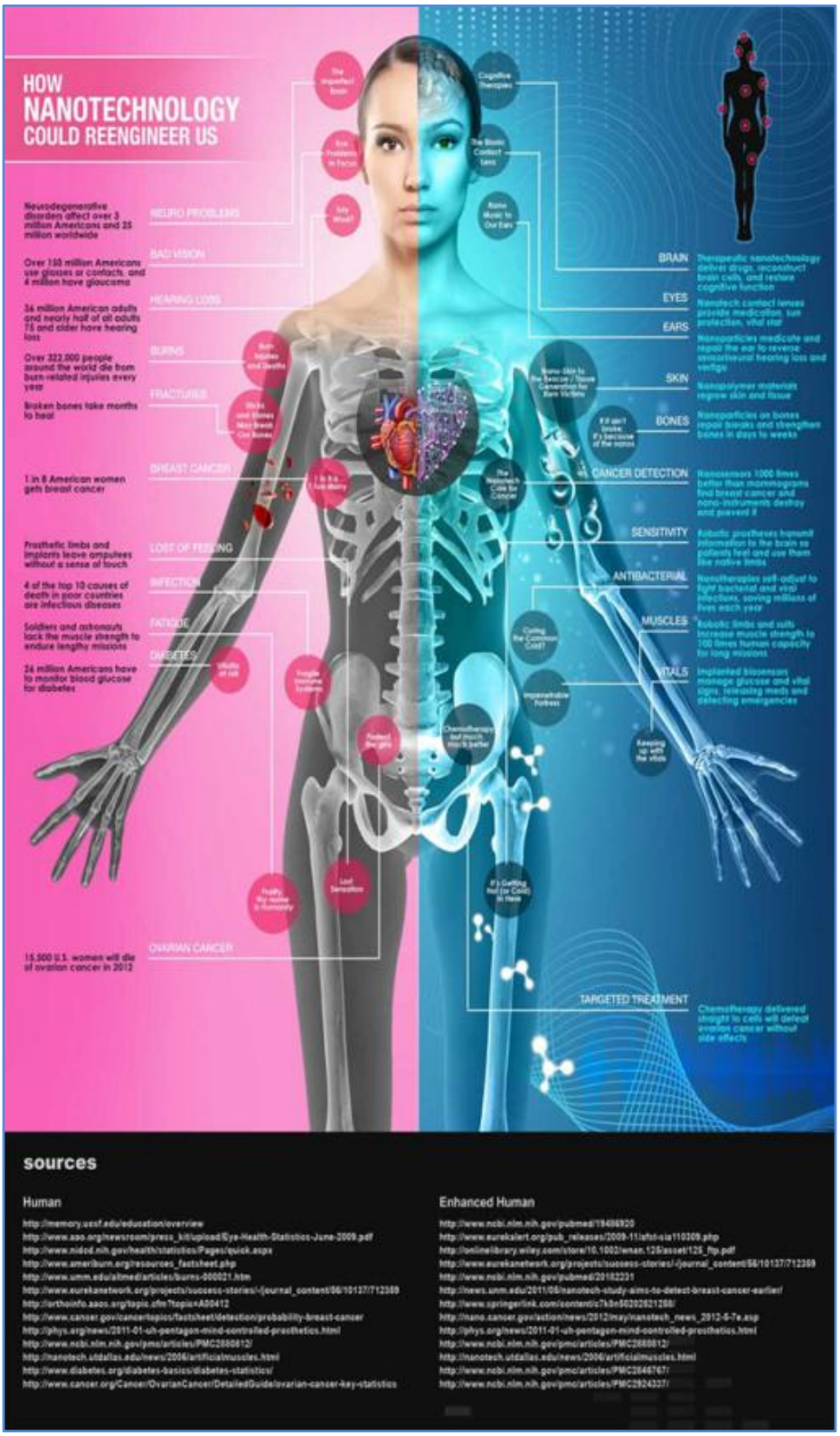
FIGURE 4: ROG HEART - [downloaded from http://www.keithley.com/knowledgecenter/How-Nanotechnology-Could-Reengineer-Us]- Keithley Instruments.



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DISCUSSION: Heath problems are not new to human race. As the civilization improving we controlled age old infectious diseases but facing unsolved problems with infectious viral diseases and non-infectious diseases like cancer, problems involving heart, brain and aging of tissue. The multidisciplinary field of nanotechnology's application for discovering new molecules and manipulating those available naturally could be dazzling in its potential to improve health care.

The advent of molecular nanotechnology will expand enormously in effectiveness, comfort and speed of future medical treatments, while at the same time significantly reducing their risk, cost and invasiveness. This science might sound like a fiction now, but Nano robotics has strong potential to revolutionize healthcare, to treat disease in future. It opens up new ways for vast, abundant research work.

Highest impact can be expected if those major diseases are addressed, which impose the highest burden on the aging population: cardiovascular diseases, cancer, musculoskeletal conditions, neurodegenerative and psychiatric diseases, diabetes and viral infections. Nano medicine holds the promise to lead to an earlier diagnosis, better therapy and improved follow up care, making the health care more effective and affordable. Nano medicine will also allow a more personalized treatment for many diseases, exploiting the in-depth understanding of diseases on a molecular level.

CONCLUSION: In the future, we could imagine a world where medical nanodevices are routinely implanted or even injected into the bloodstream to monitor health and to automatically participate in the repair of systems that deviate from the normal path to give quality life to us.

With this technology there is no need of ventilators in critical care units, no drug resistant respiratory infections, ARDS cases will be treated without ventilator and no deaths due to cardio-respiratory failure. Human society can live without fear of AIDS, SARS and Ebola virus infections.

Likewise, this technology is a double edged weapon. It should not be taken for granted the dangers and negative consequences of when applied in destructive purpose. The disasters associated with its application in energy generation when and wherever it strikes or the risks associated with nanoparticles in blood circulation.

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