Respirocytes

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***Abstract*—Respirocytes are an advancing technology that aims primarily to provide an alternative to blood transfusions. They can carry hundreds of times more oxygen than natural red blood cells and have various biological applications.**

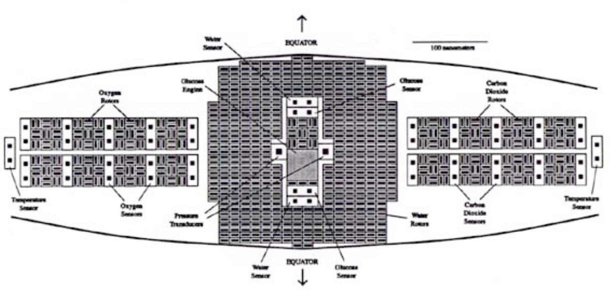
I. Introduction

The artificial respirocyte is an artificial red blood cell It is a spherical nanomedical device 1 micron in diameter consisting of 18 billion precisely arranged structural atoms plus 9 billion temporary resident molecules when fully loaded. The ballast system was scaled such that a full water tank achieves neutral buoyancy with all gas and glucose tanks empty, and an empty water tank achieves natural buoyancy with all gas and glucose tanks full. The artificial red blood cell is able to deliver 236 times more oxygen to the tissue per unit volume than natural red blood cells and can manage carbonic acidity. An onboard nanocomputer and numerous chemical and pressure sensors enable complex device behaviors remotely reprogrammable by the physician via externally applied acoustic signals.

II. Methods

Each pumping station, spaced evenly along an equatorial circle, has an array of 3-stage molecular sorting rotor assemblies for pumping O2, CO2, and H2O into and out of the ambient medium. Any one pumping station alone can load or discharge any storage tank in about 10 seconds. Gas pumping rotors are arrayed in a noncompact geometry to minimize the possibility of local molecule exhaustion during loading.

Figure 1. Pumping Station Layout (one Dodecant of Sphere Surface)



The design allows for significant numbers of output impurity return rotors because the gas rotor systems are scaled for greater than 10:1 redundancy. Each station also includes three glucose engine flues for discharge of CO2 and H20 combustion waste products, 10 environmental oxygen pressure sensors distributed throughout the O2 sorting rotor array to provide fine control if unusual concentration gradients are encountered, 10 similar CO2 pressure sensors on the opposite side, 2 external environment temperature sensors, and 2 fluid pressure transducers for receiving command signals from medical personnel.

III. Results

The respirocyte's function depends on mechanical pumping rather than chemical action. It is a device and not a drug, and devices are regulated under the provisions of the Medical Device Amendements of 1976, the Safe Medical Devices Act of 1990, and the Medical Device Amendments of 1992. In order for the FDA to approve or license any blood substitute, both efficacy and safety must be established. The product liability situation in the U.S. is such that no physician uses an experimental device unless he or she is certain of its effectiveness and safety. Also, it is currently extremely difficult to obtain an Investigational Device Exemption for clinical applications of new devices.

IV. Discussion

Primary applications will include transfusable blood substitution; partial treatment for anemia, lung disorders; enhancement of cardiovascular/neurovascular prodcedures, tumor therapies and diagnostics; prevention of asphyxia; artificial breathing; and a variety of sports, veterinary, battlefield, and other uses.

There are, however, risks to the advancing technology: hemoglobin-based blood substitutes may increase the odds of death and heart attacks. According to studies of outcomes of transfusions given to trauma patients in 2008, "Blood substitutes yielded a 30% increase in the risk of death and about a threefold increase in the chance of having a heart attack for the recipients." [2] Many other possible function failures of the respirocyte have proposed back-up systems to prevent failure of the device.

With its technology and in-depth programming, the respirocyte is capable of operating intelligently and virtually indefinitely. It will make a valuable asset to the medical community.

References

[1] Freitas, Jr,. Robert A. "Respirocytes: A Mechanical Artificial Red Cell: Exploratory Design in Medical nanotechnology." Foresight Institute, 1996-1999.Web. 116 Feb.3012. <http://www.foresight.org/Nanomedicine/Respirocytes.html#TOC>

[2] Davis, Robert. "Study: Blood Substitute Increases Risk of Death." *Study: Blood Substitute Increases Risk of Death - USATODAY.-com*. USA Today, 28 Apr. 2008. Web. 16 Feb. 2013. <http://usat-oday30.usatoday.com/news/health/2008-04-28-fake-blood-risks_N.htm>.

[3] "Blood Substitute." *Wikipedia*. Wikimedia Foundation, 02 June 2013. Web. 16 Feb. 2013. <http://en.wikipedia.org/wiki/Blood_substitute>.