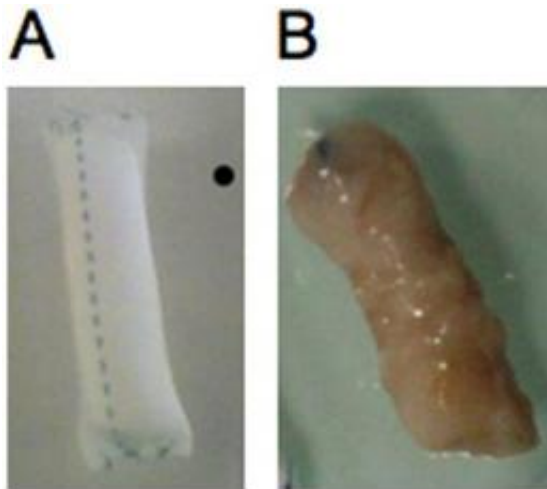


Glucose biofuel cells may soon power implants

May 19 2010, by Lin Edwards



Implants containing both GOX and catalase, immobilized on barium alginate beads, in dialysis tubing wrapped in an exPTFE coating. (A) Before implantation. (B) After 3 months of implantation. A neo-vascular network can be seen, no sign of inflammation is present, proving the good tolerance of the rat for the implant. Image credit: PLoS ONE, doi:10.1371/journal.pone.0010476

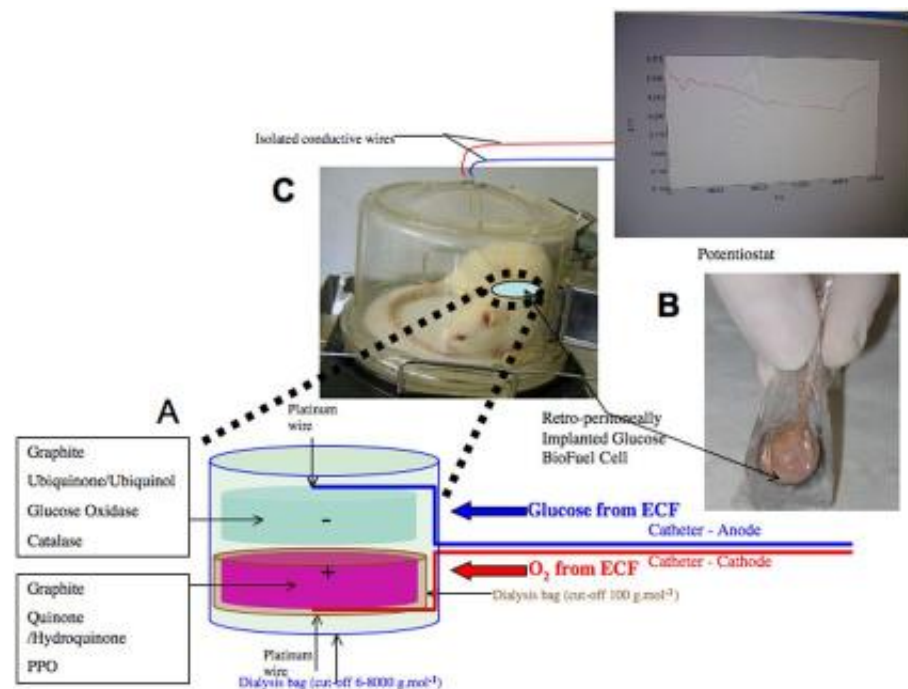
(PhysOrg.com) -- Researchers in Grenoble, France have for the first time successfully implanted glucose biofuel cells in living rats. The results suggest such cells may one day use the body's own glucose and oxygen supplies to power human implants and avoid the necessity for surgical replacement when the batteries are nearing the end of their lives.

The device consists of electrodes of compressed graphite containing

enzyme catalysts for the oxidation of glucose and chemicals called redox mediators. Redox mediators transport the electric charge from the enzymes to the electrodes leading from the fuel cell to the device it is powering. Glucose oxidase and ubiquinone were at the [anode](#), while polyphenol oxidase and quinine were at the cathode.

The enzymes and redox mediators are contained within a dialysis bag that keeps them inside but allows glucose and oxygen obtained from the bodily fluids to pass through. The devices were implanted into the rats' abdominal cavities and in one case monitored for three months. Once in place the enzymes triggered the oxidation of glucose, which generated electrical energy.

The research team, from the Joseph Fourier University, found that confining the enzymes to discs of graphite placed inside dialysis bags overcame the problems found in previous attempts at developing glucose biofuel cells (GBFCs), such as inhibition of the reaction by charged particles in the surrounding [body fluids](#), or the need for low pH conditions.



Summary of the principle, preparation, implantation and operation of an implantable “Quinone-Ubiquinone Glucose BioFuel Cell”. See the original paper for more details. Image: doi:10.1371/journal.pone.0010476

The team, led by biomedical engineer Philippe Cinquin, found in one rat the device could produce up 6.5 microwatts, and electrical output remained stable at two microwatts for 11 days, after which the rat was sacrificed. They calculated they obtained a maximum specific power of 24.4 microwatts per milliliter, which exceeds a pacemaker’s requirement of 10 microwatts.

The second rat was monitored for three months, and throughout the period its urine contained gluconate, a byproduct of glucose oxidation, indicating the device was still working. When this rat was sacrificed and dissected the scientists found a new vascular network had developed around the implant, and there was no sign of inflammation.

Cinquin said he was optimistic the efficiency could be improved, and achieving electrical outputs in the tens of milliwatts is not unrealistic in larger animals. He said he could see no reason why the devices could not work in people, and hoped to see them developed for use in humans within five to 10 years.

The biofuel cell could find application in devices such as insulin pumps, artificial urinary sphincters, biosensors, bone growth simulators and drug delivery devices as well as pacemakers. The research team want to continue their research by testing [glucose](#) biofuel cells in larger animals and for longer periods.

The paper is available online at *PLoS One*.

More information: Cinquin P, Gondran C, Giroud F, Mazabrard S, Pellissier A, et al. (2010) A Glucose BioFuel Cell Implanted in Rats. PLoS ONE 5(5): e10476. [doi:10.1371/journal.pone.0010476](https://doi.org/10.1371/journal.pone.0010476)

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