Cyborg snail produces electricity

March 15 2012, by Lisa Zyga

A snail with implanted electrodes connected with crocodile clips to external circuitry. Image credit: L. Halamkova, et al. ©2012 American Chemical Society

(PhysOrg.com) -- First it was grapes, then cockroaches, and now snails have become the latest organism to generate electricity through an implanted biofuel cell. The process works similarly in all three situations: the electricity comes from a metabolic process involving the transfer of electrons from sugar (such as glucose) to oxygen. In the case of the snail, two electrodes from a biofuel cell are implanted into holes in the snail's shell, with the anode performing glucose oxidation and the cathode performing oxygen reduction. When the electrons flow between the electrodes, they produce an electric current.

But whereas the grapes and cockroaches could generate electricity for just days or weeks, Evgeny Katz, a professor of chemistry at Clarkson University in Potsdam, New York, and colleagues have shown that the snail can generate electricity for many months at a time. And in spite of the electrodes in their shells, the snails live long, healthy lives.

“The animals are quite fit - they eat, drink and crawl,” Katz told Nature News. "We take care to keep them alive and happy.”

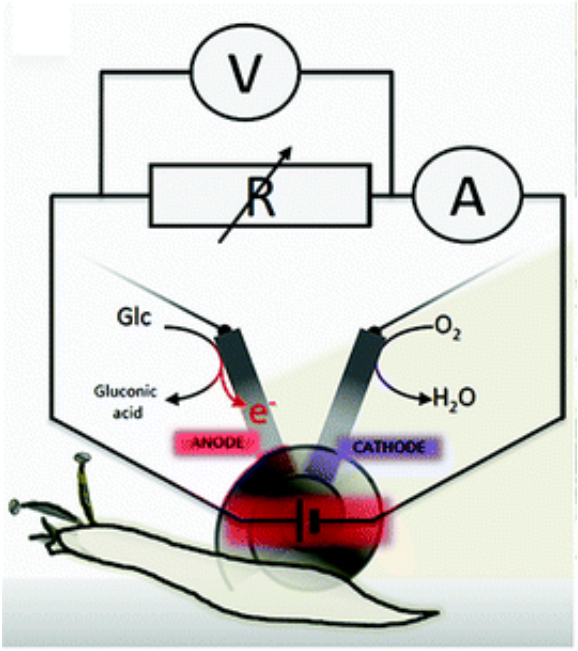

Image credit: L. Halamkova, et al. ©2012 American Chemical Society

Although a snail's tissues and organs are bathed in blood, or haemolymph, it takes time to regenerate its glucose levels, which means snails don't generate very large amounts of power. For the first few minutes, the researchers could extract 7.45 microwatts, but this power decreased to just 0.16 microwatts during long-term, continuous extraction. The main cause of this decay comes from the local depletion

of glucose at the electrode surface. Still, the snail's eating and resting could sufficiently regenerate its overall glucose levels, allowing it to "recharge" and produce sustainable electrical power.

These snails - as well as other potential electrified creatures such as worms and insects - could be useful for powering low-power devices, such as sensors and wireless transmitters. The US Department of Defense is funding cyborg research in the hopes of creating bugs that can gather information about their environment while crawling around. Researchers are also investigating medical applications, in which a patient's implantable biofuel cell could use his or her own blood glucose to power medical devices such as pacemakers.

In the future, the researchers at Clarkson University plan to electrify lobsters in the same way as the snails, with the hopes that the larger animals' metabolism could provide more power.

More information: Lenka Halámková, et al. "Implanted Biofuel Cell Operating in a Living Snail." *Journal of the American Chemical Society*. DOI: 10.1021/ja211714w

Abstract
Implantable biofuel cells have been suggested as sustainable micropower sources operating in living organisms, but such bioelectronic systems are still exotic and very challenging to design. Very few examples of abiotic and enzyme-based biofuel cells operating in animals in vivo have been reported. Implantation of biocatalytic electrodes and extraction of electrical power from small living creatures is even more difficult and has not been achieved to date. Here we report on the first implanted biofuel cell continuously operating in a snail and producing electrical power over a long period of time using physiologically produced glucose as a fuel. The "electrified" snail, being a biotechnological living "device", was able to regenerate glucose consumed by biocatalytic

electrodes, upon appropriate feeding and relaxing, and then produce a new “portion” of electrical energy. The snail with the implanted biofuel cell will be able to operate in a natural environment, producing sustainable electrical micropower for activating various bioelectronic devices.

via: Nature News