Nature's billion-year-old battery key to storing energy

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New research at Concordia University is bringing us one step closer to clean energy. It is possible to extend the length of time a battery-like enzyme can store energy from seconds to hours, a study published in the *Journal of The American Chemical Society* shows.

Concordia Associate Professor László Kálmán — along with his colleagues in the Department of Physics, graduate students Sasmit Deshmukh and Kai Tang — has been working with an enzyme found in bacteria that is crucial for capturing solar energy. Light induces a charge separation in the enzyme, causing one end to become negatively charged and the other positively charged, much like in a battery.

In nature, the energy created is used immediately, but Kálmán says that to store that electrical potential, he and his colleagues had to find a way to keep the enzyme in a charge-separated state for a longer period of time.

"We had to create a situation where the charges don't want to or are not allowed to go back, and that's what we did in this study," says Kálmán.

Kálmán and his colleagues showed that by adding different molecules, they were able to alter the shape of the enzyme and, thus, extend the lifespan of its electrical potential.

In its natural configuration, the enzyme is perfectly embedded in the cell's outer layer, known as the lipid membrane. The enzyme's structure

allows it to quickly recombine the charges and recover from a charge-separated state.

However, when different lipid molecules make up the membrane, as in Kálmán's experiments, there is a mismatch between the shape of the membrane and the enzyme embedded within it. Both the enzyme and the membrane end up changing their shapes to find a good fit. The changes make it more difficult for the enzyme to recombine the charges, thereby allowing the electrical potential to last much longer.

"What we're doing is similar to placing a racecar in on snow-covered streets," says Kálmán. The surrounding conditions prevent the racecar from performing as it would on a racetrack, just like the different lipids prevent the enzyme from recombining the charges as efficiently as it does under normal circumstances.

Photosynthesis, which has existed for billions of years, is one of the earliest energy-converting systems. "All of our food, our energy sources (gasoline, coal) — everything is a product of some ancient photosynthetic activity," says Kálmán.

But he adds that the main reason researchers are turning to these ancient natural systems is because they are carbon neutral and use resources that are in abundance: sun, carbon dioxide and water. Researchers are using nature's battery to inspire more sustainable, man-made energy converting systems.

For a peek into the future of these technologies, Kálmán points to medical applications and biocompatible batteries. Imagine batteries made of enzymes and other biological molecules. These could be used to, for example, monitor a patient from the inside post-surgery. Unlike traditional batteries that contain toxic metals, biocompatible batteries could be left inside the body without causing harm.

We're far from that right now but these devices are currently being explored and developed," says Kálmán. "We have to take things step by step but, hopefully, we'll get there one day in the not-too-distant future."

More information: 0-pubs.acs.org.mercury.concord … bs/10.1021/ja207750z

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