Protein Storage

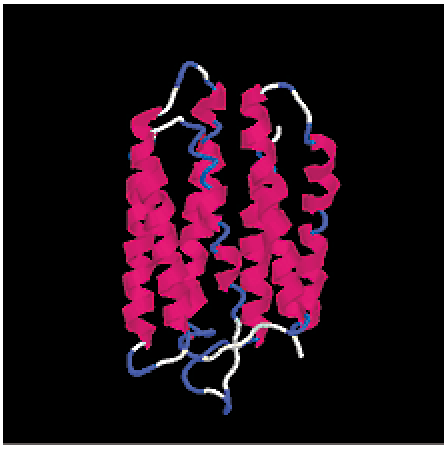

FIG. 1: The bacteriorhodopsin molecule takes on different shapes when exposed to light, making it ideal as a data-storage medium. This image depicts its ground state

You might be aware of the war now raging in consumer electronics between the HD DVD and Blu-ray formats to become the next-generation optical disc for packaged-media distribution. Both offer much greater storage capacity than DVD (15 and 25 GB per layer, respectively, compared with 4.7 GB per layer for DVD), which seems like plenty for today's media content. But if we've learned anything about media-storage capacity, it's that there's no such thing as "plenty" — at least not for long.

In the never-ending search for greater capacity, a biotechnology researcher, Dr. Venkatesan Renugopalakrishnan (known as Renu), has come up with something quite interesting. In collaboration with various corporate and university labs, Renu is developing an optical disc the size of a DVD that can store nearly 200 GB.

Whereas DVDs, HD DVDs, and Blu-ray discs store data as tiny pits in a metallic material, the storage medium on Renu's disc is a protein called bacteriorhodopsin (see Fig. 1), which was discovered in the late 1970s. This protein is found in the membrane of a microbe called Halobacterium salinarium that thrives in salty marshes, and it exhibits properties that lend themselves to data storage. As Renu explains, "When bacteriorhodopsin absorbs light, it undergoes structural changes. It flip-flops from one state to another just like a binary-switching mechanism."

These structural changes form a series of intermediate molecules that generally last for only hours or days before returning to the original ground state. Renu's research includes genetic modifications to the protein that make it stabler and more resistant to thermal breakdown than naturally occurring bacteriorhodopsin. The mutated, synthetic form can produce intermediate states that last for years. "The ground state could be the 0, and any of the intermediates could be the 1," Renu says.

As with other types of optical discs, Renu's system uses a laser to write and read data, though at much higher speeds. Those speeds have not yet been measured, but the process is theoretically capable of causing transitions from 0 to 1 or vice versa in the picosecond range. By contrast, transitions in conventional magnetic storage occur in the nanosecond range — a thousand times slower.

Each molecule measures only 2 nanometers across, which is much smaller than the data regions of conventional optical discs. Yet the system uses lasers with wavelengths in the visible range of 400 to 600 nm. How can it read and write states in individual molecules only 2 nm across? The size of the data region in conventional optical systems is limited by the wavelength of the light, but placing the laser much closer to the medium avoids that limitation. In such a near-field optical system, wavelength has no meaning and individual photons become the dominant factor, allowing much smaller regions to be addressed.

The current capacity of 200 GB is only the beginning; Renu envisions capacities of up to 50 terabytes. “This will eventually eliminate the need for hard-drive memory completely,” he says. “You have a compelling need [the insatiable desire for more capacity] that is not going to be met with the existing magnetic storage technology.”

As I've said many times, any advance in storage capacity, processor speed, or data throughput is of paramount importance to all electronic musicians. If Renu's research leads to optical discs with hundreds or thousands of gigabytes of capacity, it should appease even the most data-hungry among us for quite some time to come.

Source: http://www.co-bw.com/Audio_protein_storage.htm