Peptides may hold 'missing link' to life

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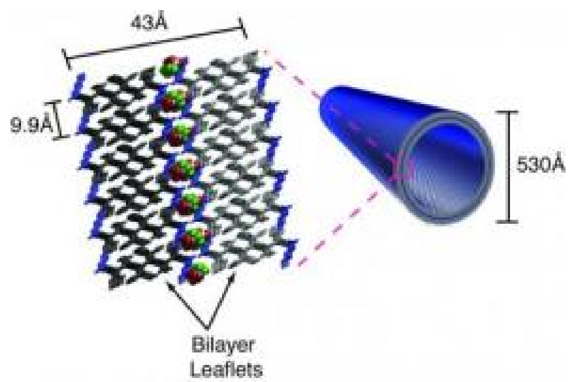

Emory University scientists have discovered that simple peptides can organize into bi-layer membranes. The finding suggests a "missing link" between the pre-biotic Earth's chemical inventory and the organizational scaffolding essential to life. Credit: Emory University

Emory University scientists have discovered that simple peptides can organize into bi-layer membranes. The finding suggests a "missing link" between the pre-biotic Earth's chemical inventory and the organizational scaffolding essential to life.

"We've shown that peptides can form the kind of membranes needed to create long-range order," says chemistry graduate student Seth Childers, lead author of the paper recently published by the German Chemical Society's *Angwandte Chemie*. "What's also interesting is that these peptide membranes may have the potential to function in a complex way, like a protein."

Chemistry graduate student Yan Liang captured images of the peptides as they aggregated into molten globular structures, and self-assembled into bi-layer membranes. The results of that experiment were recently published by the Journal of the American Chemical Society.

"In order to form nuclei, which become the templates for growth, the peptides first repel water," says Liang, who is now an Emory post-doctoral fellow in neuroscience. "Once the peptides form the template, we can now see how they assemble from the outer edges."

In addition to providing clues to the origins of life, the findings may shed light on protein assemblies related to Alzheimer's disease, Type 2 diabetes, and dozens of other serious ailments.

"This is a boon to our understanding of large, structural assemblies of molecules," says Chemistry Chair David Lynn, who helped lead the effort behind both papers, which were collaborations of the departments of chemistry, biology and physics. "We've proved that peptides can organize as bi-layers, and we've generated the first, real-time imaging of the self-assembly process. We can actually watch in real-time as these nano-machines make themselves."

The ability to organize things within compartments and along surfaces underpins all of biology. From the bi-layer phospholipids of cell membranes to information-rich DNA helices, self-assembling arrays define the architecture of life.

But while phospholipids and DNA are complicated molecules, peptides are composed of the simple amino acids that make up proteins. The Miller-Urey experiment demonstrated in 1953 that amino acids were likely to be present on the pre-biotic Earth, opening the question of whether simple peptides could achieve supra-molecular order.

To test how the hollow, tubular structure of peptides is organized, the researchers used specialized solid-state nuclear magnetic resonance (NMR) methods that have been developed at Emory during the past decade.

Working with Anil Mehta, a chemistry post-doctoral fellow, Childers tagged one end of peptide chains with an NMR label, and then allowed them to assemble to see if the ends would interact. The result was a bi-layer membrane with inner and outer faces and an additional, buried layer that localized functionality within the interior.

"The peptide membranes combine the long-range structure of cell membranes with the local order of enzymes," Childers said. "Now that we understand that peptide membranes are organized locally like a protein, we want to investigate whether they can function like a protein."

The goal is to direct molecules to perform as catalysts and create long-range order. "We'd really like to understand how to build something from the bottom up," Childers says. "How can we take atoms and make molecules? How can we get molecules that stick together to make nano-machines that will perform specific tasks?"

The research is part of "The Center for Chemical Evolution," a center based at Emory and Georgia Tech, for integrated research, education and public outreach focused on the chemistry that may have led to the origin of life. The National Science Foundation and the U.S. Department of Energy have funded the research.

Many groups studying the origins of life have focused on RNA, which is believed to have pre-dated living cells. But RNA is a much more complicated molecule than a peptide. "Our studies have now shown that, if you just add water, simple peptides access both the physical properties and the long-range molecular order that is critical to the origins of chemical evolution," Childers says.

Provided by Emory University