Simple membranes could have allowed nutrients to pass into primitive cells

June 4 2008

When the first cells developed, how could they bring molecules from the environment into their living interior without the specialized structures found on the modern cell membrane? A research team from Massachusetts General Hospital (MGH) has found that the sort of very simple membrane that may have been present on primitive cells can easily allow small molecules – including the building blocks of RNA and DNA – to pass thorough. Their report will appear in the journal *Nature* and is receiving early online release.

"We have found that membranes made from fatty acids and related molecules – the most likely components of primitive cell membranes – have properties very different from those of the modern cell membrane, which uses specialized pumps, channels or pores to control what gets in and out," says Jack Szostak, PhD, of the MGH Department of Molecular Biology and Center for Computational and Integrative Biology, the report's senior author. "Our report shows that very primitive cells may have absorbed nutrients from their environment, rather than having to manufacture needed materials internally, which supports one of two competing theories about fundamental properties of these cells."

How nutrients could get into cells without the specialized mechanisms of the modern cell membrane has been a mystery. The environment in which primitive cells formed probably included many types of fatty acids, which could have been supplied through a couple of scenarios. Fatty-acid molecules could have been formed by the action of heat and minerals deep beneath the earth's surface and then brought to the surface

through deep-sea vents, hot springs or geysers; or they could have come to the earth's surface on meteorites. No matter the original source, when fatty acids are concentrated in water, they will naturally assemble into membranes which then close into tiny spherical structures called vesicles.

Szostak's team carefully analyzed vesicles comprised of different fatty acid molecules and identified particular features that made membranes more or less permeable to potential nutrient molecules. They found that, while large molecules such as strands of DNA or RNA could not pass through fatty acid membranes, the simple sugar molecules and individual nucleotides that make up larger nucleic acids easily crossed the membrane.

To further explore the function of a fatty acid cell membrane, the researchers used activated nucleotides they developed for this study that will copy a DNA template strand without needing the polymerase enzyme usually required for DNA replication. After placing template molecules inside fatty-acid vesicles and adding the activated nucleotides to the external environment, they found that additional DNA was formed within the vesicles, confirming that the nucleotide molecules were passing through the fatty-acid membranes.

"Today we have complex cells living in a chemically simple environment, but the primitive environment was chemically very complex, allowing for the synthesis of complex organic chemicals that cannot be formed in today's environment," Szostak explains. "We think that the first cells were very simple and assembled from molecules present in localized environments on the early earth."

For many years, Szostak's team has been working on the development of a 'protocell' that would replicate probable features of the earth's first cells. "The chemistry of nucleic acid replication is the remaining hard

part," he says. "We're putting a lot of effort into nucleic acid chemistry, but there are also other interesting and important questions – like how cells made the transition from very leaky early membranes to today's very impermeable membranes – that we are starting to study."

Source: Massachusetts General Hospital

Citation: Simple membranes could have allowed nutrients to pass into primitive cells (2008, June 4) retrieved 27 April 2024 from https://phys.org/news/2008-06-simple-membranes-nutrients-primitive-cells.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.