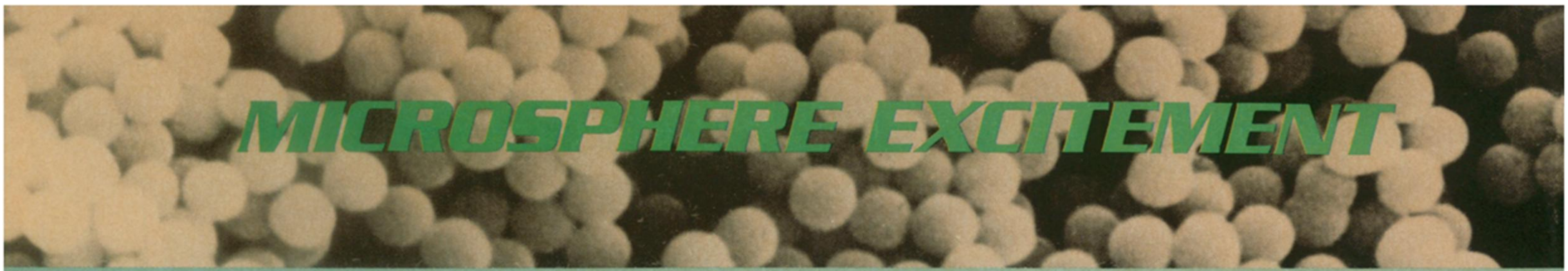


# MICROSPHERE EXCITEMENT

## Primitive, proteinlike material seems to be able to organize itself into simple, microscopic spheres that, like cells, can show electrical activity

By IVARS PETERSON

CORAL GABLES, FLA. — Immersed in total darkness, a hair-thin shaft of white light bathes the surface of a microscopic ball of proteinlike material. Two electrodes, one puncturing the tiny sphere's skin—a double-layered membrane—and the other sitting in the surrounding salty fluid, detect an electrical signal. In a nearby room, researchers monitor and trace the microsphere's electrical activity.

For more than two decades, Sidney W. Fox has been exploring the properties of these "proteinoid" microspheres — artificial cells he calls them—at his Institute for Molecular and Cellular Evolution at the University of Miami. Over the years, he and various collaborators have discovered that these extremely simple structures show properties that are strikingly similar to those of modern, living cells.

For Fox, these experiments are important pieces in the puzzle of how, at the beginning of life, molecules organized themselves into protocells that evolved into living cells. Unlike other scientists who argue that the components of cells (nucleic acids, lipids and proteins) arose first and then a membrane formed to create the first cells, Fox suggests that protocells surrounded by proteinoid membranes were present from the very beginning of the evolution of modern cells.

Most recently, Fox and his colleagues Aleksander T. Przybylski and Robert M. Syren have discovered that microspheres can generate electrical signals resembling those generated in nerve or muscle cells. These microspheres are the product of a process that begins with a heated stew of various amino acids. The acids spontaneously join together in definite patterns to form long polymer chains. When water is added and the mixture is heated again (or processed in some other way), the polymers organize themselves into spheres, a few microns in diameter. Each sphere consists of a two-layer membrane with some residual material trapped inside. It is this membrane that turns out to have a remarkable array of properties.

A microsphere's membrane is similar to the lipid bilayer that encloses "normal, modern cells," says Syren, although the microsphere's layer is thicker. If such a membrane formed early in the molecular evolution of life (something that these experiments indicate is possible), it would form a sheltered, stable environment in which the more complicated parts of a cell could evolve, he says.

Light seems to be the principal energy source for a microsphere's electrical activity. The membrane proteinoids appear to contain molecular groups that act like pigments and absorb light, says Przybylski. The incoming light frees electrons from the membrane, and the membrane somehow allows a separation of charge to occur by keeping the electrons from returning to their original positions.

Light energy may have been the most important energy source for the simplest precursors of living cells, Przybylski says. "We are dealing with entities that behave in a very stable way for a long time. Things don't decay because they can take light energy in to compensate for dissipative effects," he says. "Light keeps charging up the battery."

Because a microsphere's electrical system is so complicated, Fox's group is now starting to look for the "minimum recipe" —the simplest combination of amino acid starting materials that forms microspheres able to show electrical activity. Their experiments have already revealed that some combinations of amino acids produce membranes that generate electrical oscillations or impulses very similar to those of neurons. "There exists a fundamental analogy between the electrical phenomena of the artificial proteinoid cell ... and evolved natural excitable cells," concludes Przybylski.

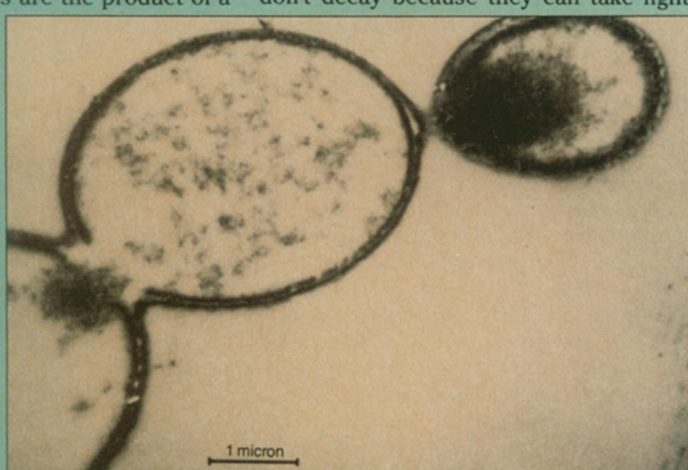
The role of the proteinoid molecular pigments is the target of other planned studies designed to unravel the complicated electrical system within the membrane. The researchers also hope to use a tunable laser to pinpoint how the electrical effect depends on the incident light's wavelength.

Przybylski speculates that it may be possible to take advantage of the self-organizing tendency and the consequent electrical activity observed in microspheres. Just as excitable microspheres form spontaneously under the right conditions, it may be possible to create molecular switches that practically assemble themselves. These switches could then be built into "biochips" for molecular computers (SN: 6/11/83, p. 378).

The work on proteinoid microspheres also has applications in modeling natural proteins, membranes and cells, Fox says. One can change at will the composition of constituent amino acids and then monitor the behavior of the polymers.

In addition, his experiments provide clues to the "origin of mind," Fox says. They indicate that the electrical features characteristic of neurons are present in some form as intrinsic features of simple organized entities like his microspheres. This implies that some of the components of "mind" may have existed in the earliest forms of life on earth.

"We are tremendously surprised," says Fox, "at how much modern functions are present in these proteinoid microspheres, which are models of protocells." □




Steven Brooke

*Double-layered membranes that define the boundaries of proteinoid microspheres are clearly visible in this micrograph. These membranes are often photosensitive and may show neuronlike electrical activity.*



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