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Origins of Nervous System Found in Genes of Sea Sponge, Report Scientists at UC Santa Barbara

Scientists at the University of California, Santa Barbara have discovered significant clues to the evolutionary origins of the nervous system by studying the genome of a sea sponge, a member of a group considered to be among the most ancient of all animals.

The findings are published in the June 6 issue of the journal PLoS ONE, a Public Library of Science journal. The article can be found at <http://www.plosone.org/article/info:doi/10.1371/journal.pone.0000506>.

"It turns out that sponges, which lack nervous systems, have most of the genetic components of synapses," said Todd Oakley, co-author and assistant professor in the Department of Ecology, Evolution and Marine Biology at UC Santa Barbara.

"Even more surprising is that the sponge proteins have 'signatures' indicating they probably interact with each other in a similar way to the proteins in synapses of humans and mice," said Oakley. "This pushes back the origins of these genetic components of the nervous system to at or before the first animals -- much earlier than scientists had previously suspected."

When analyzing something as complex as the nervous system, it is difficult to know where to begin, explained Ken Kosik, senior author and co-director of UCSB's Neuroscience Research Institute, who holds the Harriman Chair in Neuroscience Research.

The first neurons and synapses appeared over 600 million years ago in "cnidarians," creatures known today as hydra, sea anemones, and jellyfish. By contrast, sponges, the oldest known animal group with living representatives, have no neurons or synapses. They are very simple animals with no internal organs.

"We look at the evolutionary period between sponges and cnidarians as the period when the nervous system came into existence, about 600 million years ago," said Kosik.

He explained that the research group made a list of all the genes expressed in a synapse in humans, since synapses epitomize the nervous system. Synapses are involved in cell communication, learning, and memory. Next, the researchers looked to see if any of the synapse genes were present in the sponge.

"That was when the surprise hit," said Kosik. "We found a lot of genes to make a nervous system present in the sponge." The research team also found evidence to show that these genes were working together in the sponge. The way two of the proteins interact, and their atomic structure, bear resemblance to the human nervous system.

"We found this mysterious unknown structure in the sponge, and it is clear that evolution was able to take this entire structure, and, with small modifications, direct its use toward a new function," said Kosik. "Evolution can take these 'off the shelf' components and put them together in new and interesting ways."

The research was made possible through the use of the sequenced sponge genome. The sponge genome has not yet been published, but it is available on-line. The sequencing was done by co-author Bernard M. Degnan, who was previously a postdoctoral fellow with Dan Morse, professor in the Department of Molecular, Cellular and Developmental Biology and director of UCSB's Institute for Collaborative Biotechnologies. Degnan is now a professor in the School of Integrative Biology at the University of Queensland in Brisbane, Australia.

This research on the genes of the sponge is highly interdisciplinary and includes computer scientists, biologists, and neuroscientists. The first author is Onur Sakarya, a graduate student at UCSB's Neuroscience Research Institute. He is also affiliated with UCSB's Department of Computer Science and the Department of Molecular, Cellular and Developmental Biology. Co-author I-Fan Wang is also with the Neuroscience Research Institute as a postdoctoral fellow. Other co-authors include Bruce Tidor, professor, and Kathryn A. Armstrong, graduate student, both with the Biological Engineering Division and the Computer Science and Artificial Intelligence Laboratory at the Massachusetts Institute of Technology. Additional co-authors from the School of Integrative Biology at the University of Queensland include Maja Adamska, a postdoctoral fellow, and Marcin Adamski, a research assistant.

Philanthropist Harvey Karp provided some of the funding for the work.

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