Extracts

Sea Slugs May Provide Clues To Memory, Learning

James C. Netherton III

Neuroscience and zoology Assistant Professor Leonid Moroz with one of the sea slugs he is using to study the role that genes play in brain function. With the biggest brain cells in the animal kingdom, the sea slug makes an ideal research model.

A team of University of Florida and Columbia University scientists will probe the genetic underpinnings of nerve cells, including those responsible for learning and memory, through research on a common sea slug with a very uncommon brain.

With the aid of a nearly $11 million federal grant from the National Institutes of Health's National Human Genome Research Institute, the team will study the sea slug's unusual brain to try to unmask the role that genes play in its higher functions. The research at the newly created Center of Excellence in Genomic Sciences at UF and Columbia may help improve understanding of how the brain and its nerve cells function, identify the genetic basis of brain disorders such as dementia, and pave the way for new techniques or drugs to improve healthy people's ability to learn and remember.

"There is no way to discover real treatments using drugs, or understand diseases or understand our learning capability, unless you understand how all the components of the system work, including the genomics," said Leonid Moroz, an assistant professor of neuroscience and zoology at UF's Whitney Laboratory for marine biomedical research and biotechnology and one of the team's leaders.

The purple-brown sea slug, a mollusk known scientifically as *Aplysia californica* that reaches 6 to 7 pounds, is native to the West Coast, where it eats seaweed. While unremarkable in appearance, the slug has the biggest brain cells in the animal kingdom — with the largest measuring 1 millimeter.

That's far larger than microscopic human brain cells, making the slug cells simpler to examine and manipulate in the laboratory, Moroz said. The slug also has only about 10,000 neural cells, compared with 100 billion in humans, greatly simplifying the task of mapping the connections between cells and learning how cell networks determine behaviors, including those related to learning and memory, he added.

The sea slug shares as many as half of its estimated 15,000 to 20,000 genes with people, including genes implicated in Alzheimer's and mental retardation, so understanding how these genes work in the slug's neural cells will lead directly to greater insight into how they work in people's brain cells, Moroz said.

"This animal provides a beautiful system for research," he said. "As an example, three large nerve cells from this animal placed in a petri dish will do all the jobs that a neuroscientist can dream of: They will learn, forget and show us all the genes that make it happen."

The slug brain's unique physical characteristics have made it the focus of research on higher brain functions for more than a half century. The research already has resulted in significant breakthroughs — for example, spurring the development of drugs, now in clinical trials, expected to reverse memory loss in some elderly people, Moroz said.

The UF and Columbia researchers plan to count and identify the genes active in single neural cells and learn how they work together. They also plan to develop new nanotechnologies for studying genes in single nerve cells. They'll use the knowledge, among other things, to probe which genes are active during learning, and which are actively involved in memory, both of which the slug, through a range of observed behaviors such as its defensive reflexes and feeding habits, has shown itself to be capable, Moroz said.

"This work, which has the potential to radically change our understanding of the brain, wouldn't be possible without the unique features of the slug brain," said Peter Anderson, director of the Whitney Laboratory. "It exemplifies the utility of marine and other comparative models in modern biological research."

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