

Finding expands understanding of neurons

April 19 2007

Many significant discoveries have enriched our exploration and understanding of the brain, including one of its most active cellular elements – neurons – since the brain was first described in 7,000 B.C. by Egyptian scholars.

Scientists know basics behind how nerves transmit action potentials, the concepts of electrical and chemical transmission, and identified a variety of pumps, pores, and proteins, as well as a range of ion channels (sodium, potassium and calcium), designed to propagate or modulate neuronal activity.

Now, ASU neurophysiologist Carsten Duch and doctoral student Stefanie Ryglewski have discovered evidence that a voltage sensor might exist that directly activates an intracellular calcium release mechanism, via a G-protein. It had been thought that G-proteins were activated by G-protein coupled receptors and not by voltage sensors. This new finding may expand scientist's understanding about how individual neurons manage multiple tasks.

In the human brain, with more than 100 billion neurons packed into a space the size of a small cantaloupe, individual neurons are bombarded by information from their neighbors. How they manage to process and integrate these inputs – and appropriately manage their outputs – is therefore central to coming to an understanding of how coordinated brain activity as a whole arises.

“Think about all the tasks that a neuron has to do and all the different

types of information being processed in one cell,” says Duch, an associate professor in the School of Life Sciences. “We believe this sensor adds another tool to the toolbox for neurons to manage information.”

In a paper published in the journal *Public Library of Science Biology* March 6, Duch and Ryglewski outline how this newly identified, voltage-dependent G-protein activation works in the locust *Schistocerca gregaria*. According to Duch, it is well understood that when a nerve cell fires an action potential, calcium ions move across the membrane through voltage-dependent membrane channels. This movement, in turn, causes the release of intracellular stores of calcium and results in the regulation of multiple cellular processes, such as gene transcription, cytoskeletal rearrangements or even cell death. However, until Duch's work in PLoS Biology, it was believed that electrical excitation of a neuron-induced calcium release from internal stores only when calcium ions moved across the membrane. In fact, their work demonstrates that intracellular calcium stores can also be released in response to voltage changes, without the movement of ions.

How significant a finding is this and is there an analog in other insect or mammalian systems? Duch says it is too soon to know, but he and Ryglewski already are taking the next steps to find out. Ryglewski is visiting from the Freie Universitat in Berlin – where Duch worked before coming to the College of Liberal Arts and Sciences in 2006, and both scientists are at work setting up their experimental system in the fruit fly, *Drosophila*.

“This research only tells us what is happening in a cell culture system and about mechanisms in individual cells, but not about systems,” Duch says. “The next step is to take this discovery and look in a system that is genetically well-defined, such as *Drosophila*. But what we can say is that since large portions of membranes in neurons do not have calcium

channels, a sensor solely activated by electrical charges adds a previously unanticipated calcium signaling possibility to neuron's intracellular communication machinery.”

Source: ASU

Citation: Finding expands understanding of neurons (2007, April 19) retrieved 10 April 2024 from https://medicalxpress.com/news/2007-04-neurons_1.html

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