Major discovery explains how adult brain cleans out dead brain cells, produces new ones

August 10 2011

(Medical Xpress) -- Adult brains generate thousands of new brain cells called neurons each day; however only a small fraction of them survive. The rest die and are consumed by scavenger cells called phagocytes. Until now, scientists have not fully understood how this process works, which phagocytes are unique in the brain, and how the removal of dead neurons influences the production of new neurons.

In humans, neurogenesis, or the formation of new neurons, largely ceases in most areas of the brain during adulthood. However, in two brain areas there is strong evidence that substantial numbers of new neurons are naturally generated (in the hippocampus, which is involved in memory forming, organizing and storing, and the olfactory bulb, involved in the perception of odors).

UVA Health System researchers have made a pivotal discovery in understanding this complicated process, and their findings could one day help scientists devise novel therapies to promote neurogenesis in the adult brain and re-establish its function in patients suffering from depression, post-traumatic stress disorder, and other mental disorders, in which adult neurogenesis is impaired .

The findings appear in a study published online July 31, 2011 in the journal Nature Cell Biology and led by two UVA researchers -- Jonathan Kipnis, PhD, associate professor of neuroscience, and Kodi S.

Ravichandran, PhD, chair of the UVA Department of Microbiology and director of the UVA Center for Cell Clearance. Zhenjie Lu, PhD, is the first author on this work and was instrumental in combining the methodologies in the Kipnis lab (which focuses on basic mechanisms underlying neurological disorders) and the Ravichandran lab (which focuses on cell clearance) to address adult neurogenesis through a combination of in vivo studies in normal and genetically altered mice, and ex vivo studies using neuronal cultures.

Through their research, UVA scientists discovered that certain types of progenitor cells, called the doublecortin (DCX)-positive neuronal progenitors (or "newborn neurons"), serve a dual role in the regulation of production and elimination of new brain cells. Progenitor cells generally act as a repair system for the body, replenishing special cells and maintaining blood, skin and intestinal tissues. This new discovery points to the ability of these cells to clean each other out, which ultimately benefits the regeneration process.

"Our study provides the first evidence that DCX+ cells, in addition to serving their function as neuronal precursors in the brain, also function as phagocytes [scavenger cells] by clearing out their dead brethren -- and that this process is required to maintain continuous generation of new neurons in the brain," says Kipnis.

"These findings raise the possibility that this newly discovered process could be manipulated to rejuvenate the brain by regulating the addition of new neurons," says Ravichandran.

This discovery, Kipnis adds, also could shed new light on our understanding of how the process of adult neurogenesis is regulated in the healthy brain, and in turn provide insights on diseased brains, where adult neurogenesis is severely impaired.

“The birth and death of new neurons in the adult brain have been implicated in ongoing learning and memory,” says Kevin Lee, PhD, chair of the Department of Neuroscience and professor of neurological surgery. “The findings by Kipnis, Ravichandran, Lu and associates are fascinating, because they describe a novel process regulating the production and removal of adult-born neurons. This represents an important step toward identifying mechanisms that might be manipulated to control the number of new neurons in the adult brain. Regulating new adult neurons in this manner could open a novel avenue for modifying basic cognitive functions, including learning.”

More information: Research paper: www.nature.com/ncb/journal/vao … nt/full/ncb2299.html

Provided by University of Virginia

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