New understanding of basic units of memory

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A molecular “recycling plant” permits nerve cells in the brain to carry out two seemingly contradictory functions – changeable enough to record new experiences, yet permanent enough to maintain these memories over time.

The discovery of this molecular recycling plant, detailed in a study appearing early online Sept. 19 in the journal *Neuron*, provides new insights into how the basic units of learning and memory function. Individual memories are “burned onto” hundreds of receptors that are constantly in motion around nerve synapses – gaps between individual nerve cells crucial for signals to travel throughout the brain.

According to the study’s leader, Duke University Medical Center neurobiologist Michael Ehlers, M.D., Ph.D., these receptors are constantly moving around the synapse and often times they disappear or escape. Ehlers discovered that a specific set of molecules catch these elusive receptors, take them to the recycling plant where they are reprocessed and returned to the synapse intact.

“These receptors constantly escape the synapse and are in a perpetual state of recycling,” said Ehlers, who is also a Howard Hughes Medical Institute investigator. “This process occurs on a time scale of minutes or hours, so the acquisition of new neurotransmitter receptors and their recycling is an on-going process. Memory loss may result from receptors escaping from the synapse.”

All this activity takes place on millions of tiny “nubs,” or protrusions in

the synapses known as dendritic spines. The recycling plants are located within the body of these dendritic spines.

“We believe that the existence of this recycling ability explains in part how individual dendritic spines retain their unique identity amidst this constant molecular turnover,” Ehlers said. “The system is simultaneously dynamic and stable.”

While these findings should be able to help neurobiologists as they attempt to understand the molecular foundations of learning and memory, Ehlers believes that this knowledge could also be helpful in explaining what happens in certain neurological disorders, such as Alzheimer’s disease, schizophrenia, or learning disorders like autism.

For example, it appears that in animal models of the early phases of Alzheimer’s disease, often before any symptoms become apparent, the dendritic spines gradually lose their ability to transport and recycle the receptors.

“If the receptors don’t get recycled, you see a gradual loss of synaptic function that is associated with reduced cognitive ability,” Ehlers said. “These dendritic spines are where learning and memories reside. These are the basic units of memory.”

Source: Duke University Medical Center