Study shows how daughter is different from mother

August 19 2008

The mother-daughter relationship can be difficult to understand. Why are the two so different? Now a Northwestern University study shows how this happens. In yeast cells, that is.

A research team has discovered a new mechanism for cell fate determination -- how one cell, the daughter, becomes dramatically different from the mother, even though they have the same genetic material. The study shows why mothers and daughters differ in how they express their genes.

The results of this research will be published in the Aug. 19 issue of the journal PLoS Biology.

By studying yeast, whose entire genome is known, scientists can learn the basics of cell division and apply that knowledge to the human system. Many of the fundamental mechanisms for cell division in yeast are conserved, or very similar, in mammals; many of the proteins involved in human disease are related to proteins that are involved in yeast cell division.

The new knowledge about cell fate determination could lead to a better understanding of healthy human cells, what goes awry in cancer cells and how human stem cells and germ cells work.

"Cancer may reflect a partial and aberrant loss of differentiated character, in which cells that were formerly specified to perform a

specific task 'forget' that, and become more like the rapidly dividing stem cells from which they came," said Eric L. Weiss, assistant professor of biochemistry, molecular biology and cell biology in Northwestern's Weinberg College of Arts and Sciences. Weiss led the research team, which included scientists from the Massachusetts Institute of Technology.

"Understanding how differentiated states are specified might help us figure out how to remind cancer cells to go back to their original tasks or fates -- or, more likely, die."

When a yeast cell divides it produces a mother cell and a smaller, different daughter cell. The daughter cell is the one that actually performs the final act of separation, cutting its connection to the mother cell. And the daughter takes longer than the mother to begin the next cycle of division, since it needs time to grow up.

The key to the researchers' discovery of how this differentiation works is the gene regulator Ace2, a protein that directly turns genes on. The researchers found that the protein gets trapped in the nucleus of the daughter cell, turning on genes that make daughter different from mother.

The team is the first to show that the regulator is trapped because a signaling pathway (a protein kinase called Cbk1) turns on and blocks Ace2 from interacting with the cell's nuclear export machinery. Without this specific block, the machinery would move the regulator out of the nucleus, and the daughter cell would be more motherlike -- not as different.

"Daughter-cell gene expression is special, and now we know why," said Weiss.

The researchers also found that the differentiation of the mother cell and daughter cell -- this trapping of the regulator in the daughter nucleus -- occurs while the two cells are still connected.

Source: Northwestern University