Researchers use light to move molecules

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Using a light-triggered chemical tool, Johns Hopkins scientists report that they have refined a means of moving individual molecules around inside living cells and sending them to exact locations at precise times.

This new tool, they say, gives scientists greater command than ever in manipulating single molecules, allowing them to see how molecules in certain cell locations can influence cell behavior and to determine whether cells will grow, die, move or divide. A report on the work was published online December 13 in the Journal of the American Chemical Society.

Studying how just one signaling molecule communicates in various parts of a living cell has posed a challenge for scientists investigating how different interactions influence cell behavior, such as the decision to move, change shape or divide.

"By using one magical chemical set off by light, we modified our previous technique for moving molecules around and gained much more control," says Takanari Inoue, Ph.D., assistant professor of cell biology and member of the Center for Cell Dynamics in the Institute for Basic Biomedical Sciences. "The advantage of using light is that it is very controllable, and by confining the light, we can manipulate communication of molecules in only a tiny region of the cell," he says.

Specifically, the Hopkins team designed a way to initiate and spatially restrict the molecular interactions to a small portion of the cell by attaching a light-triggered chemical to a bulky molecule, the bond

between which would break when researchers shined a defined beam of ultraviolet light on it. This enabled the chemical to enter the cell and force two different and specific proteins in that cell to mingle when they otherwise wouldn't. Normally, these proteins would have nothing to do with each other without the presence of the light-triggered chemical, but researchers decided to take advantage of this mingling to explore how certain proteins in a cell behave when transported to precise locations.

Next, researchers modified the two mingling proteins by attaching special molecules to them — one sent one of the proteins to the edge of the cell and another caused ripples to form on the edge of the cell — so that if ripples form on the edge of the cell, they would know that the proteins were interacting there.

The researchers put both modified proteins inside human skin cells and bathed the cells in the light-triggered chemical tool. Then, they shone a tiny UV beam directed on approximately ten percent of the edge of a skin cell. Ripples appeared only on the region of the cell near where the light was beamed, demonstrating that the tool could limit cell activity to a precise location in the cell.

The tool can be used in larger cells, Inoue says, to monitor as little as one percent of a specific molecule if the beam intensity is varied. That in turn could reveal in even more detail the secret affairs of proteins in cellular cubbyholes.

"With this technique, we can get a finer understanding of cell function on the molecular level," says Inoue. "Our technique allows us to monitor whatever molecule we choose in whichever tiny space we choose so that we can understand how a molecule functions in a specific part of a live cell."

More information: pubs.acs.org/journal/jacsat

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