Molecular motor grows cell's microtubules

October 26 2015

Motor proteins that pause at the ends of microtubules and produce pushing forces can also stimulate their growth, according to researchers at Penn State. The proteins' function could be a critical component in understanding cell division and nerve branching and growth.

Kinesins are a family of motor proteins found in multicellular organisms. They function as 'little engines' within the cells and transport molecular cargo along microtubules, among other activities. The microtubules—25 nanometers thick or one ten- thousandth the diameter of a human hair—are hollow cylinders of the protein tubulin. They are extremely dynamic and have the ability to grow and shrink as the cell changes shape.

"We are trying to get under the hood of these motors and understand what makes their sequences unique," said William Hancock, professor of biomedical engineering, Penn State. "Because they carry out so many vital functions in the cells of the body, we really want to understand how they operate at the molecular level."

In total, there are 45 different kinesin motor proteins in humans. Hancock and Yalei Chen, graduate student in cell and developmental biology, Penn State's Huck Institute of the Life Sciences, tracked the movements of individual fluorescently-tagged kinesin-5 molecules in the laboratory and found that the motor pauses at the end of the microtubules. It then generates pushing forces, which slide the microtubules apart and essentially allow the motor to grow the microtubules. The researchers reported their results in a recent issue of

Nature Communications.

The researchers bound microtubules to the surface of a microscope slide and added free tubulin subunits together with modified kinesin-5 motor proteins. The results, observed under a fluorescence microscope, showed that the addition of the motor proteins increased both the rate and the persistence of microtubule growth.

Understanding kinesin-5's role in microtubule growth should provide a better understanding of its role in stabilizing and growing the mitotic spindle during cell division.

The mitotic spindle is a scaffold that ensures duplicated chromosomes are properly segregated during each round of cell division. The final result is two completely new cells containing identical genetic material. Understanding how the scaffold is formed is important for understanding cell division and this scaffold formation is also a potential target for inhibiting cell division.

"Cancer cells are the fastest growing cells in a cell population," Hancock said. "They are the ones that most need to be able to break down and reassemble their microtubule network."

The ability to terminate cancer cell division could one day lead to new approaches in treatment.

The researchers hope to expand their work to investigate how kinesin-5 influences microtubule dynamics in dividing cells and the role it plays in properly segregating genetic material in cell division.

Provided by Pennsylvania State University