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Physics, math provide clues to unraveling cancer

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Biology exists in a physical world. That's a fact cancer researchers are beginning to recognize as they look to include concepts of physics and mathematics in their efforts to understand how cancer develops -- and how to stop it.

The movement, led by researchers at the University of Michigan Comprehensive Cancer Center, has come to a head with a new section in one of the top cancer research journals and a new grant program from the National Cancer Institute.

Traditional cancer biology involves taking a sample of cells and holding them in time so they can be studied. Then the researchers look at that slice of cells to understand what signals and pathways are involved. But that doesn't capture the full picture, says Sofia Merajver, M.D., Ph.D., co-director of the Breast Oncology Program at the U-M Comprehensive Cancer Center.

"The living cell is really a dynamic process. We need to consider the properties of physics to help us understand these data. In order to develop a drug directed against a given molecule that has real hope of treating cancer, we need to understand how that molecule is sitting in the cell, interacting with other molecules," says Merajver, professor of internal medicine at the U-M Medical School.

Merajver and her team have developed a sophisticated mathematical model to help researchers apply these concepts to cancer. The

mathematical model is designed to help give researchers a complete picture of how a cell interacts with its surrounding environment. By understanding the full complexity of signaling pathways, researchers can better target treatments and identify the most promising potential new drugs.

Researchers have learned from this modeling that a well-known and major type of signaling pathway naturally transmits information not just in a forward direction, but also backwards. That implies new considerations for developing drugs to inhibit major growth and metastasis pathways in cancer.

This crosstalk was missed by conventional methods. Typically, when scientists begin to look at a cell, they must make assumptions to simplify the picture of what is happening in cells.

"When you make simplifying assumptions, you always run the risk of eliminating critical aspects of your system, but you have no way of knowing what was discarded. When you simplify, you don't know exactly what you're throwing away because you never looked at the complex case," Merajver says. Mathematical modeling allows researchers to look at the complex case more thoroughly.

"To understand how the laws of physics can be applied to biological systems is a new frontier," she says.

Merajver and her colleagues were successful in getting the journal *Cancer Research* to add a new regular section to the twice-monthly journal precisely focused on mathematical modeling. The journal has also added new editors to its board who have expertise in this discipline. Merajver and Trachette Jackson, Ph.D., professor of mathematics at U-M, will lead this effort as senior editors.

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