Mathematics reveals genetic pattern of tumor growth

June 21 2007

Using mathematical theory, UC Irvine scientists have shed light on one of cancer's most troubling puzzles -- how cancer cells can alter their own genetic makeup to accelerate tumor growth. The discovery shows for the first time why this change occurs, providing insight into how cancerous tumors thrive and a potential foundation for future cancer treatments.

UCI mathematicians Natalia Komarova, Alexander Sadovsky and Frederic Wan looked at cancer from the point of view of a tumor and asked: What can a tumor do to optimize its own growth" They focused on the phenomenon of genetic instability, a common feature of cancer in which cells mutate at an abnormally fast rate. These mutations can cause cancer cells to grow, or they can cause the cells to die.

The scientists found that cancerous tumors grow best when they are very unstable in early stages of development and become stable in later stages. In other words, tumors thrive when cancerous cells mutate to speed up malignant transformation, and then stay that way by turning off the mutation rate.

The study appeared this week in the Royal Society journal Interface.

"Mathematical theory can help us understand cancer," said Komarova, associate professor of mathematics at UCI. "If we know what cancer is doing, we might be able to find ways to fight it."

Previous studies have observed this genetic pattern by using laboratory

techniques, but the UCI research is the first to explain why the pattern leads to tumor growth. The occurrence of genetic instability is often debated by cancer scientists, some of whom believe that cancer feeds on this instability and others who believe it is a side-effect of the cancer itself.

To determine the pattern of genetic changes that leads to the most robust tumor growth, Komarova and her colleagues used a mathematical technique called optimal control theory in which they considered a tumor with set characteristics, then changed the cell mutation variable to see under which circumstances the tumor grew best.

“The mutation rate serves as the control knob. Then, we can calculate mathematically how long it takes a tumor with given parameters to reach a certain size,” Komarova said. “We found that at early stages of tumor growth, instability is advantageous, and later on it becomes an impediment. This explains why many tumors exhibit a high level of instability at first, and become stable later in their development.”

Source: University of California - Irvine