Researchers use cell 'profiling' to detect abnormalities -- including cancer

January 25 2011, by Pam Frost Gorder

An Ohio State University mathematician and his colleagues are finding ways to tell the difference between healthy cells and abnormal cells, such as cancer cells, based on the way the cells look and move.

They are creating mathematical equations that describe the shape and motion of single cells for laboratory analysis.

Though this research is in its early stages, it represents an entirely new way of identifying cell abnormalities, including cancer. It could one day be useful in gauging future stages of a disease -- for example, by detecting whether cancer cells are aggressive and likely to spread throughout the body, or metastasize.

In a paper published online in the *Bulletin of Mathematical Biology*, researchers describe a mathematical model which analyzes image sequences of single, live cells to determine abnormalities manifested in their shape and behavior. A brain tumor cell was one of the cell types they analyzed in the study.

Huseyin Coskun, visiting assistant professor of mathematics at Ohio State and leader of the project, described their novel approach as a first step toward developing mathematical tools for diagnosing cell abnormalities and for giving potential prognoses.

Because the technique would allow doctors to view how cancer cells behave under different physical or chemical conditions, it could also be used to test different treatment strategies for each individual patient -- such as determining the most efficient dose of chemotherapeutic agents or radiation -- or even to test entirely new treatments.

In addition, Coskun sees his technique as a tool for also pathologists, who typically look at photographs of biopsied cells to identify cancer and judge how advanced the cancer may be.

"A pathologist can diagnose cancer, but as far as predicting the future, they don't have many tools at their disposal -- particularly if a cancer is in its early stages," Coskun said. "That's why I believe that one of the most important applications of this research is profiling cancer cells. Given a cell's motion and its morphological changes, we want to be able to determine what's happening inside the cell. If it looks like a cancer cell, and a particularly aggressive one, we would like to quantify how likely it is that the cancer cells will invade the body."

In a very basic sense, diagnosing a "sick" cell such as a cancer cell by its appearance, motion, and behavior is analogous to diagnosing a sick human, he said. "When we get sick, our behavior changes. We may stay in bed, sleep a lot -- maybe we are coughing or sneezing. These are basic symptoms that a doctor will consider to determine if we're sick. Abnormalities oftentimes manifest themselves as behavioral changes in all living organisms. Therefore, a careful analysis of and profiling the behavioral patterns of single cells could provide valuable information."

Cell motion is important for all life, he continued. White blood cells move when they attack microbes that have invaded the body. A wound heals when newly grown cells move in to close it. But something about aggressive cancer cells causes them to move from the tumor where they originated into the blood stream, where they migrate to different organs and grow out of control.

Living cells often change shape, expand, or contract, and Coskun believes that he and his colleagues can create unique "personality profiles" of cancer cells.

Coskun and his colleague, Hasan Coskun, assistant professor of mathematics at Texas A&M University-Commerce, used a branch of physics called continuum mechanics to derive equations that describe cells' appearance and behavior. They compared their model outcomes to findings from past cancer studies, which indicated that cancer cells are more deformable than normal cells.

The researchers discovered that their model results agree with those experimental findings.

Obtaining data from live cell image sequences to use as an input in the mathematical models is not easy. For this, Coskun collaborated with Hakan Ferhatosmanoglu, an associate professor, and his then-student, Ahmet Sacan, both of computer science and engineering at Ohio State. They created open source software called CellTrack to extract data from movies of cell motion.

Given a movie of live cells under the microscope, CellTrack tracks individual cells, extracts data that can be used in the mathematical models, and provides other useful statistical information about the motion.

Huseyin Coskun acknowledged the current limits of his methodology. The researchers were able to show that their mathematical models can be applied to analyze single cell motion and obtain useful information. They were also able to hypothesize a biological explanation for very complex mechanism of cell motion based on their mathematical model outcomes. But he and his partners need many more high-resolution movies of healthy cells and cancer cells to build upon this initial work. That's why

Coskun is setting up collaborations with medical researchers at Ohio State and other universities.

Coskun believes that mathematical techniques such as his are becoming more common in the biomedical sciences because they allow researchers to perform studies that would be too difficult, time-consuming or expensive in real life. He hopes his technique could be used to answer emerging questions in cell biology.

Provided by The Ohio State University

Citation: Researchers use cell 'profiling' to detect abnormalities -- including cancer (2011, January 25) retrieved 17 April 2024 from https://phys.org/news/2011-01-cell-profiling-abnormalities-cancer.html