Surface tension drives segregation within cell mixtures

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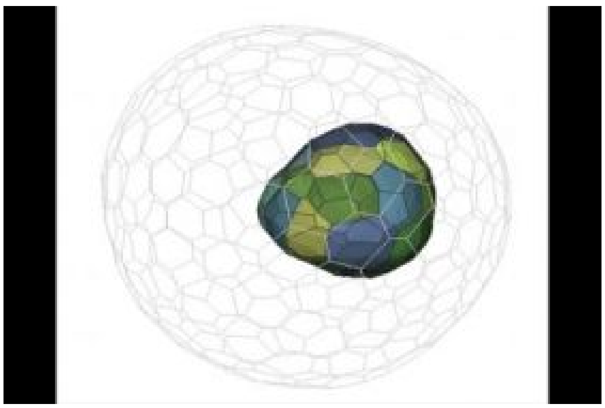

The output of a new 3-D computer of the cell sorting process shows a mixture of two types of cells -- one type shown in color and the other transparent -- that have separated as a result of the force of surface tension. Credit: Shane Hutson, Vanderbilt University

What does a mixture of two different kinds of cells have in common with a mixture of oil and water? The same basic force causes both mixtures to separate into two distinct regions.

That is the conclusion of a new three-dimensional computer model of the cell sorting process produced by Shane Hutson, assistant professor of physics at Vanderbilt University, and his colleagues at the University of Waterloo in Canada that is described in the Oct. 3 issue of the journal Physical Review Letters.

The force in question is surface tension – a property of liquids that arises from intermolecular forces – specifically an effect called the Plateau-Rayleigh Instability that explains the tendency of water to form droplets.

Mechanical interactions between cells play an important role in a number of biological processes, including the development of embryos and the spread of cancer. Understanding these interactions is particularly important in current efforts to create artificial tissues.

"In order to design and control the building of artificial tissues of any sort, we have to understand how cell/cell interactions drive shape and structure formation at a very deep level," Hutson says.

Currently, these interactions are often modeled using analogs from fluid mechanics including viscosity and surface tension. "What we have shown is a fascinating new role for surface tension in the process of cell sorting – the ability of random mixtures of two cell types to spontaneously sort themselves into two distinct domains," Hutson says.

Previous 2-D and 3-D models of cell sorting had indicated that surface tension alone was not powerful enough to drive this "unmixing" process by itself, leading researchers to propose that the cells themselves must also change shape randomly to keep the process from grinding to a halt before it is completed.

The new computer model looked at the structure of the 3-D mixtures in greater detail. It showed that in mixtures where the minority cell type makes up at least 25 percent of the mix, more than 95 percent of the minority cells are in direct contact with other minority cells instead of being totally surrounded by majority cells and found that this contact enhances the surface tension effect, allowing it to drive the sorting process without assistance from cell fluctuations.

Source: Vanderbilt University