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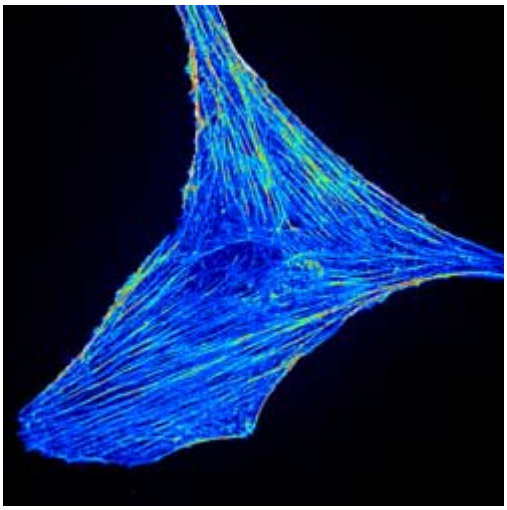
Title and Authors

A Cellular Glass Menagerie

Human beings are fragile creatures: Our hearts can be shattered, our emotions crushed. But a paper appearing in the 1 October print issue of *PRL* takes human frailty to a new level by suggesting that our cells actually resemble molten glass. This surprising finding is based on the measurement of a cell's ability to resist when deformed. The results could be useful in understanding diseases like asthma, cancer, and infections, all of which involve a change in cells' mechanical properties.



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Handle with care. This mouse fibroblast cell exhibits behavior similar to that of molten glass, foams, and other semi-ordered materials, according to researchers.

Some theories describe cells as elastic membranes filled with liquid--something like a water balloon. If the membrane is alternately tugged and pressed at a low frequency, the cell is springy, but at higher frequencies the liquid inside causes it to stiffen. Many researchers believe that if a cell is vibrated through a wide range of frequencies, it will suddenly become stiffer with increasing frequency over a narrow frequency spread.

But a new study questions that view. A team led by Ben Fabry of Harvard University wanted to see how smooth muscle cells (a type of cells found in the lungs and bronchi) responded to being vibrated. To each cell's membrane they attached a 5-μm-diameter magnetic bead. When placed under an oscillating magnetic field, the bead rolled back and forth across the surface, pulling on the cell membrane at the attachment point. A video camera recorded that vibration and fed it to a computer, which used a simple algorithm to determine the motion of the bead to within 5 nm. By varying the strength and frequency of the field, the researchers could describe how the cells responded to being jostled.

As expected, the cells initially jiggled, but rather than suddenly stiffening, they gradually hardened as the frequency rose. "This result was most surprising to us," says Fabry, because it was inconsistent with the water balloon model. Instead, the behavior resembled that of glasses, a broad category of non-crystalline materials that includes window glass as well as mixtures of liquids and particles. Fabry and his team believe that long protein molecules inside the muscle cells behave like molten glass particles, which are constantly rearranging themselves in a search for order.

"I think it's very exciting that they seem to have found these concepts of soft glassy materials extending into biological materials," says Peter Sollich, of King's College in London. But, adds Sollich, the classification of living cells as a glassy material is still somewhat tentative. He believes that further research into other characteristics of the cell is necessary before a conclusion can be reached. Still, Fabry says that if he is correct, this work could fundamentally alter the way researchers regard cells. It may also help them to understand diseases such as asthma, whose origins may lie in the mechanical properties of smooth muscle cells in the respiratory system.

--Geoff Brumfiel

Related story: Toothpaste-like materials may also be glasses (story from 28 November 2000).