https://doi.org/10.1017/S1551929500056200 Published online by Cambridge University Press

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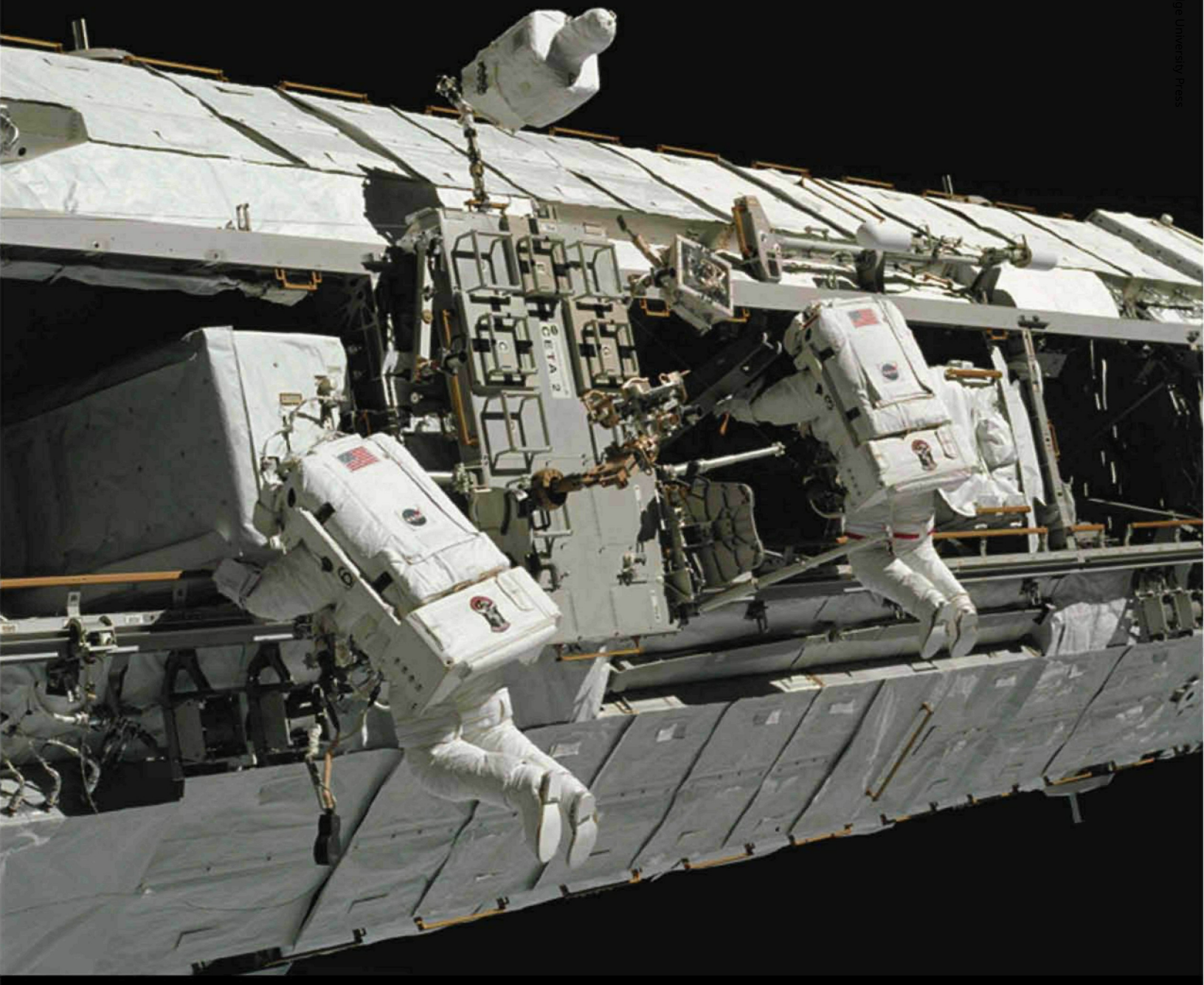
SEPTEMBER 2004 VOLUME 12 NUMBER 5



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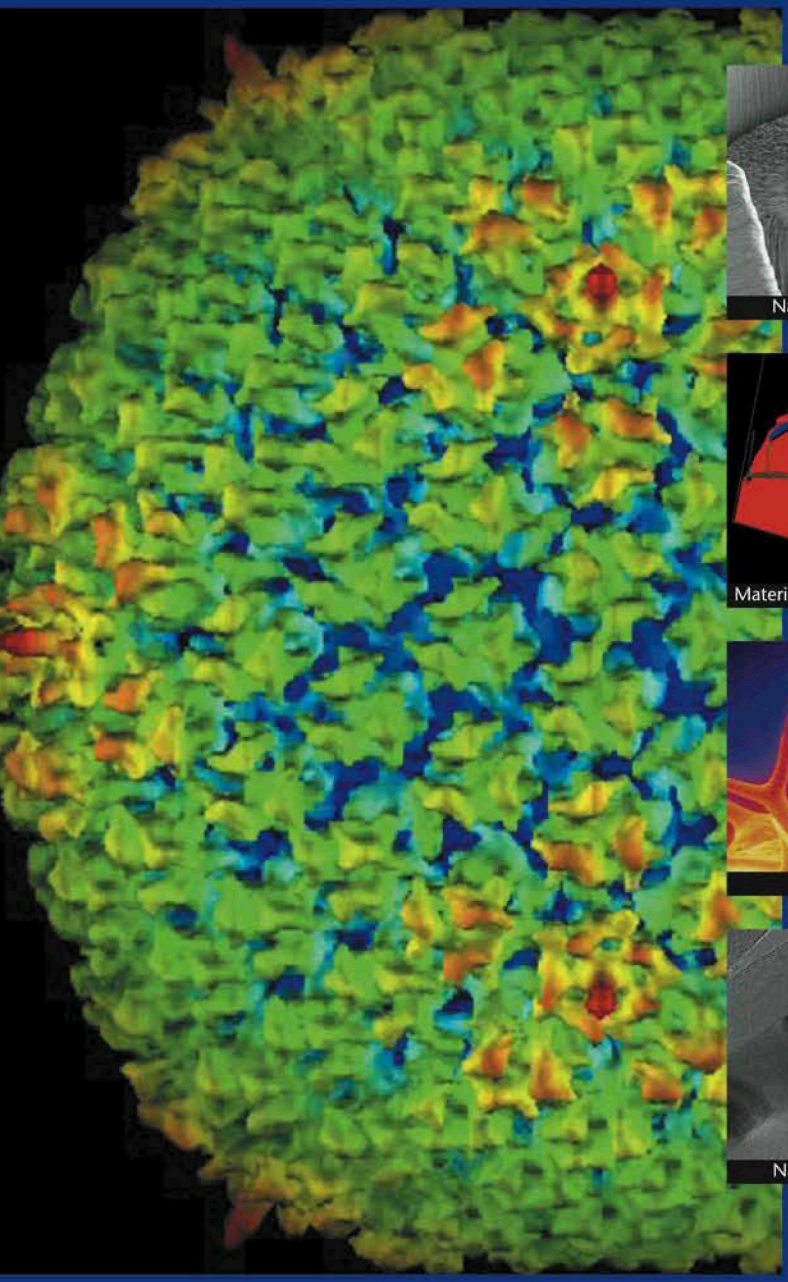

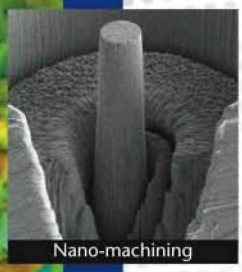
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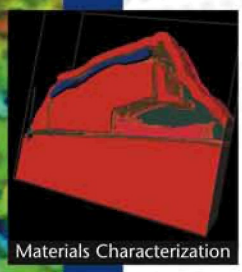
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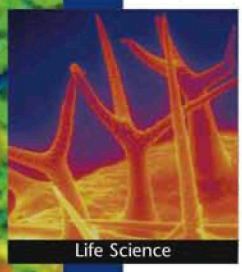
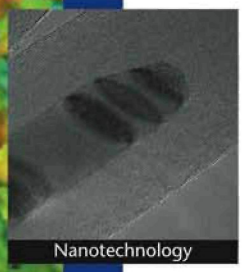

Life Science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We wish to thank Dr. Phoebe Stewart, Vanderbilt University Medical Center, for the three-dimensional reconstruction of adenovirus, a human respiratory virus, based on cryo-electron micrographs (large image). The viral surface is color coded according to height and the view is along a 2-fold icosahedral symmetry axis.

Cells Connected by Tiny Tunnels

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Intracellular communication is imperative for multicellular organisms. Such devices as synapses and gap junctions have been recognized for decades. Now Amin Rustom, Rainer Saffrich, Ivanka Markovic, Paul Walther, and Hans-Hermann Gerdes have described a new model of cell-to-cell communication.[2]

While looking at PC12 (rat pheochromocytoma) cells in the presence of fluorescently labeled wheat germ agglutinin, Rustom *et al.* observed relatively long connections extending between cells. These structures were 50 to 200 nm in diameter and up to several cell diameters in length and were named tunneling nanotubes (TNTs). TNTs were subsequently found connecting cultured cells from other lines. They were consistently positioned along the smallest distance between the cells, did not contact the substrate, and occasionally were branched. TNTs immunostained positive for actin, but did not contain microtubules. Scanning and transmission electron microscopy definitively established that a TNT represented a seamless continuity of the plasma membrane from one cell to another.

Does a TNT represent a residual structure from cell division? No, rather they appear to form actively between unrelated cells. Over a period of minutes, a cell formed filopodia-like protrusions that appeared to be reaching out to another cell, like a blind person grasping for contact. Once one protrusion made contact, the other protrusions degenerated. A substance that depolymerizes F-actin (latrunculin-B) eliminated the TNTs, suggesting that actin-driven protrusions participate in TNT formation.

What is the purpose of a TNT? Interestingly, endosome-related particles could be seen to move in one direction along a TNT, at a rate of about 26 nm/second. However, smaller molecules, such as green fluorescent protein nor calcein (a small dye) did not appear to move between TNT-connected cells. So the TNT appears to be filled with F-actin that facilitates the transfer of relatively large structures between connected cells, but smaller molecules appear to be confined to their original cells. Several other experiments and observations were done by Rustom *et al.* that were consistent with this result.

TNTs appear to form as one of a few actin-driven protrusions that reach out to target cell(s), and once contact is made, the other protrusions disappear. Organelles, but not small molecules, can be unidirectionally transferred from the cell that presumably initiated the protrusion to the target cell. Although Rustom *et al.* pointed out that similar mechanisms have been documented in plants (at least in principle), this appears to represent a new means of communication between animal cells. It will be interesting to see if TNTs can be located in developing organisms or established animal tissues. This may open up an entirely new avenue of communication between cells, and this avenue is a tiny tube! ■

1. The author gratefully acknowledges Dr. Hans-Hermann Gerdes for reviewing this article.

2. Rustom, A., R. Saffrich, I. Markovic, P. Walther, and H.-H. Gerdes, Nanotubular highways for intercellular organelle transport, *Science* **303**:1007-1010, 2004.

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ABOUT THE COVER

Work underway on the International Space Station

See the article by Donald Gillies on page 8. The Materials Science Program of NASA's Office of Biological and Physical Research (OBPR) has attacked fundamental problems of materials science. While the program's primary objectives are science-based and despite the fact that 90% of these programs concentrate on pre-cursor and theoretical research on the ground, NASA demands that there be a microgravity rationale driving the research.