Not everybody was startled by the discovery. "We looked on it as a confirmation of our [earlier] hypothesis," says geophysicist G. Randy Keller of the University of Texas, El Paso. In 1983 Keller and geophysicist colleagues had proposed that the great buried rift that 1.2 billion years ago had cracked open 2200 kilometers of the continent from Kansas to Lake Superior and down through Michigan didn't end there, as most researchers thought. Instead, Keller and his colleagues had drawn on gravity data suggesting that dense, iron-rich lavas had erupted to the south of Michigan. The lavas, they proposed, erupted along an eastern extension of the rift that continued another 600 kilometers to the Tennessee border. "It looked like the continent just about broke apart," says Keller.

The three-survey consortium is suggesting that their sedimentary basin is part of the that rift scar. Although other researchers differ on the details, the consortium's history of North America has the continent rifting open 1.2 billion years ago along a great arc from Kansas to Tennessee, quite near what was then the eastern margin of the continent. What drove the rifting is unclear, but some geophysicists think a plume of hot mantle may have been rising below Lake Superior, stretching the continent. In any case, huge eruptions were spewing lavas all along the rift when, almost miraculously, the rifting stopped. North America was saved. Its salvation may have been a squeeze by the approaching Grenville Province, a chunk of continent that shortly thereafter collided with North America east of Ohio.

That may have been an even closer call for North America than the Ohio discovery suggests. At the meeting Donald Adams of the University of Texas, El Paso, and Keller suggested that the western arm of the rift may have extended well beyond Kansas into New Mexico. Thank goodness for colliding continents.

–Richard A. Kerr

CELL BIOLOGY

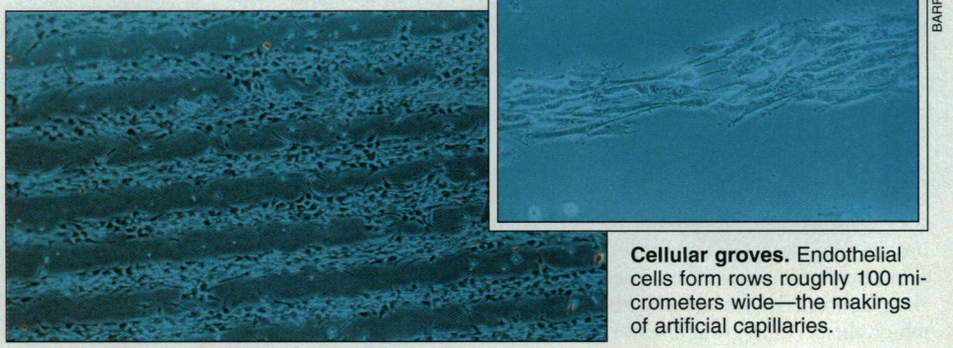
A New Kind of Organic Gardening

Biophysicist David Stenger of the Naval Research Laboratory (NRL) has developed a passion for precision gardening. Don't expect any prize tomatoes from his plots, though; what he and his colleagues grow are cells, and their gardens are culture dishes. By combining clever surface chemistry with fabrication techniques adapted from the microelectronics industry, they lay out patterns of molecular soil that encourage cells to take root and grow only in certain places. Other researchers had demonstrated the possibility in the late 1980s, but last month Stenger and his collaborators reported a new level of precision: They can now coax cells to grow in molecular flower beds of almost arbitrarily fine geometries.

Stenger, chemist James Hickman of Science Applications International Corp., and their co-workers aren't just imposing order for its own sake. By regimenting cells in precise networks, they and others hope to create a range of devices for basic science and technology. As a means of spreading out neurons so that their behavior and interactions can be more precisely monitored, the networks promise to serve as test beds for neuroscience and perhaps as sensitive detectors of chemical and biological warfare agents. And by mimicking the organized growth patterns of capillaries in the body, these artificial arrangements of cells could also play a role in medicine—as a kind of vascularized cellular gauze for wound repair.

The inspiration is biology's own artful cellular organization. During development, for example, cell adhesion molecules act like lighted aisles, directing migrating cells to their proper locations. Scientists had already known they could roughly control the wanderings of cultured cells by patterning surfaces with substances such as polylysine and fibronectin, which interact with molecules on the cells' surfaces. But David Kleinfeld of AT&T and two colleagues get credit for showing in 1988 that finer control could be achieved by enlisting the photolithographic techniques of microelectronics to create intricate patterns of cell-attracting and cell-shunning molecules.

Kleinfeld's original technique included multiple steps, but in the 26 April 1991 *Science*, Stenger and collaborators from the NRL and other institutions presented what they hoped was a simpler strategy. In their method, ultraviolet light shines through a stencil-like mask onto films of organosilane—a compound to which cells will not stick. The light, however, chemically alters the exposed regions, and a subsequent chemical step converts them into a hydrophilic, and thus cell-friendly, form. The result, as Stenger, Hickman, and co-workers now report in the 21 October *Journal of the American Chemical Society*, is "precise geometric control of the adhesion and growth of mammalian neural and endothelial cells." In one striking demonstration, the workers laid down cell-friendly molecules in a pattern reminiscent of minute chicken wire, then watched rat hippocampal cells stitch themselves to the nodes of the mesh and grow neural projections along its strands.



BARRY SPARGO

Cellular groves. Endothelial cells form rows roughly 100 micrometers wide—the makings of artificial capillaries.

Such feats have been turning heads. In January, for example, the Marine Corps began funding Stenger and colleagues in a project to test the potential of patterned neuroblastoma cells, which react to a menagerie of toxins, as sensing elements for chemical and biological warfare agents. Tiny electrodes or other detectors arrayed directly underneath the cells would register toxin-related changes in cell behavior. Meanwhile, the Office of Naval Research is supporting Stenger's group to study the computer-like features of single neurons, which can integrate and process many inputs. And groups at NRL and Cornell University are working with Stenger's team to develop ways of preforming endothelial cells into networks of artificial capillaries. One goal is to lace these networks of ersatz blood vessels into biodegradable polymers to form a prevascularized, skin-like material for treating burns and other serious wounds.

Stenger and his many collaborators don't have a monopoly in the cellular gardening business. Cell biologists Gregory Brewer of the Southern Illinois University School of Medicine and Bruce Wheeler of the University of Illinois, for example, hope that these cellular networks will help shed light on the behavior of small sets of neurons. Scientists already have tools such as EEG recorders for monitoring whole brain activity and microelectrodes for eavesdropping on single neurons, Brewer says. But by growing networks of neurons, he adds, "we can now work between these levels [of brain structure]."

Cellular gardening, it would seem, promises some bountiful harvests.

–Ivan Amato