AgentCell simulates cell populations as they sense, repond to their environment

Scientists at the University of Chicago and Argonne National Laboratory have constructed a computer simulation that allows them to study the relationship between biochemical fluctuations within a single cell and the cell's behavior as it interacts with other cells and its environment.

The simulation, called AgentCell, has possible applications for cancer research, drug development and combating bioterrorism. Other simulations of biological systems are limited to the molecular level, the single-cell level or the level of bacterial populations. AgentCell can simultaneously simulate activity on all three scales, something its creators believe no other software can do.

AgentCell can simulate the behavior of entire populations of cells as they sense their environment, respond to stimuli and move in a three-dimensional world. AgentCell enables scientists rapidly to run test experiments on the computer, saving them valuable time in the laboratory later.

AgentCell will be used to tackle a major goal in single-cell biology today: to document the connection between internal biochemical fluctuations and cellular behavior. They may even reveal why cells sometimes act as individuals and sometimes as part of a community.

Each digital cell in AgentCell is a virtual *Escherichia coli*, a single-celled bacterium, which is equipped with all the virtual components necessary to search for food. These digital *E. coli* contain their own chemotaxis system, which transmits the biochemical signals responsible for cellular locomotion. They also have flagella, the whip-like appendages that cells use for propulsion, and the motors to drive them.

The digital bacterial system is designed in modules, so that additional components may be added later. The basic system is a simple model, containing primarily a sensory system. But additional components that simulate other biological processes—cell division, for example—can also be introduced.

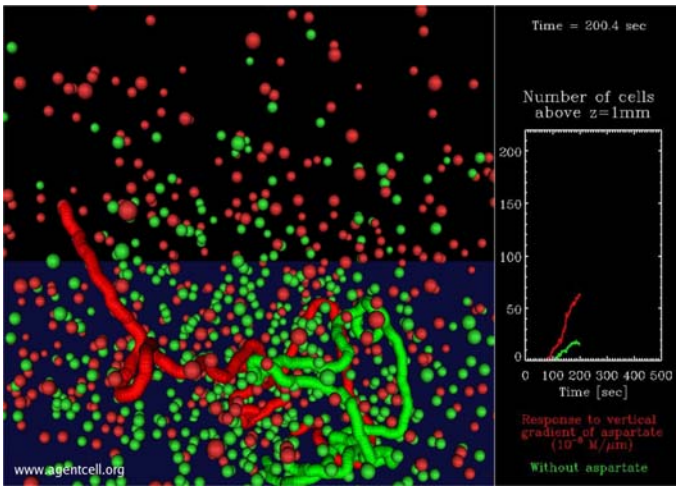

Image from a three-dimensional AgentCell animation showing more than 1,000 virtual cells swimming in an environment that grows richer in nutrients as the move toward the top of the image. Red cells are sensitive to the nutrient, but green cells are not.

Researchers have already derived benefits from AgentCell in its basic form, finding that one type of protein controls the sensitivity of *E. coli*'s chemotaxis system, which helps the bacteria find food.

AgentCell was made possible by agent-based software, which researchers in Argonne's Center for Adaptive Systems Simulation developed to simulate stock markets, social behavior and warfare. The work was funded by the U.S. Department of Energy and the University of Chicago/Argonne National Laboratory Seed Grant Program. The code is available for download from the Web site at www.agentcell.org.

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