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Biological Computers: Genetically Modified Cells Communicate Like Electronic Circuits

Genetically modified cells can be made to communicate with each other as if they were electronic circuits. Using yeast cells, a group of researchers at the University of Gothenburg, Sweden, has taken a groundbreaking step towards being able to build complex systems in the future where the body's own cells help to keep us healthy. The study was presented recently in an article in the scientific journal Nature.

"Even though engineered cells can't do the same job as a real computer, our study paves the way for building complex constructions from these cells," says Kentaro Furukawa at the University of Gothenburg's Department of Cell- and Molecular Biology, one of the researchers behind the study. "In the future we expect that it will be possible to use similar cell-to-cell communication systems in the human body to detect changes in the state of health, to help fight illness at an early stage, or to act as biosensors to detect pollutants in connection with our ability to break down toxic substances in the environment."

Combining biology and technology

Synthetic biology is a relatively new area of research. One application is the design of biological systems that are not found in nature. For example, researchers have successfully constructed a number of different artificial connections within genetically modified cells, such as circuit breakers, oscillators and sensors.

Some of these artificial networks could be used for industrial or medical applications. Despite the huge potential for these artificial connections, there have been many technical limitations to date, mainly because the artificial systems in individual cells rarely work as expected, which has a major impact on the results.

Biotechnology challenges the world of computers

Using yeast cells, the research team at the University of Gothenburg has now produced synthetic circuits based on gene-regulated communication between cells. The yeast cells have been modified genetically so that they sense their surroundings on the basis of set criteria and then send signals to other yeast cells by secreting molecules. The various cells can thus be combined like bricks of Lego to produce more complicated circuits. Using a construction of yeast cells with different genetic modifications, it is possible to carry out more complicated "electronic" functions than would be the case with just one type of cells.

The University of Gothenburg research team is headed by professor Stefan Hohmann, and also comprises Kentaro Furukawa and Jimmy Kjellén.

The article Distributed biological computation with multicellular engineered networks, published in the scientific journal Nature on 8 December, was the result of a partnership with two Spanish research teams at Universitat Pompeu Fabra in Barcelona. The work forms part of the EU CELLCOMPUT project.

Sergi Regot, Javier Macia, Núria Conde, Kentaro Furukawa, Jimmy Kjellén, Tom Peeters, Stefan Hohmann, Eulàlia de Nadal, Francesc Posas, Ricard Solé. Distributed biological computation with multicellular engineered networks. Nature, 2010; DOI: 10.1038/nature09679