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Scientists Create Artificial Network-Like Cell System

Scientists at the Weizmann Institute have created an artificial, network-like cell system that can reproduce the dynamic behaviour of protein synthesis. This is a significant achievement as it will not only enable scientists to gain a better understanding of basic biological processes but may also pave the way toward controlling the synthesis of both naturally occurring and synthetic proteins.

The system has been designed by PhD students Eyal Karzbrun, Alexandra Tayar and Professor Roy Bar-Ziv of the Weizmann Institute in collaboration with Professor Vincent Noireaux of the University of Minnesota. The research is supported by the Yeda-Sela Centre for Basic Research.

This system is comprised of multiple compartments that have been etched onto a biochip. Each artificial cell is a millionth of a meter in depth and the cells are connected via thin capillary tubes, thus creating a network that enables the diffusion of biological substances throughout the system. The researchers have inserted a cell genome within each compartment that is designed and controlled by them.

During their experiment, the team relinquished control to E.coli by filling up the compartments with E.coli cell extract without its DNA code. They then observed the protein synthesis dynamics. The research team coded two regulatory genes and created a protein synthesis rate that was periodic, switching from “on” to “off”. The amount of time between each switch was determined by the geometry of the compartments.

“The artificial cell system, in which we can control the genetic content and protein dilution times, allows us to study the relation between gene network design and the emerging protein dynamics. This is quite difficult to do in a living system,” says Karzbrun. “The two-gene pattern we designed is a simple example of a cell network, but after proving the concept, we can now move forward to more complicated gene networks. One goal is to eventually design DNA content similar to a real genome that can be placed in the compartments.”

The team of scientists also investigated whether the artificial cells could actually communicate and interact with one another like real cells. They found that the synthesized proteins that diffused through this array of interconnected compartments were able to regulate genes and could produce new proteins. The created system, in fact, closely resembled the initial stages of morphogenesis, the biological process that governs the emergence of the body plan in embryonic development.

According to Bar-Ziv, with this artificial cell system, one could encode anything. Different components could be mixed and matched to produce different outcomes. The team wants to further expand the system and introduce gene networks that could mimic pattern formation. It is believed that this research can definitely help advance the synthesis of fuel, pharmaceuticals, chemicals and the production of enzymes.

Source: Weizmann Institute of Science
Image credit: Weizmann Institute of Science (the team comprising of Eyal Karzbrun, Alexandra Tayar and Prof. Roy Bar-Ziv)

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