Protocells use DNA logic to communicate and compute

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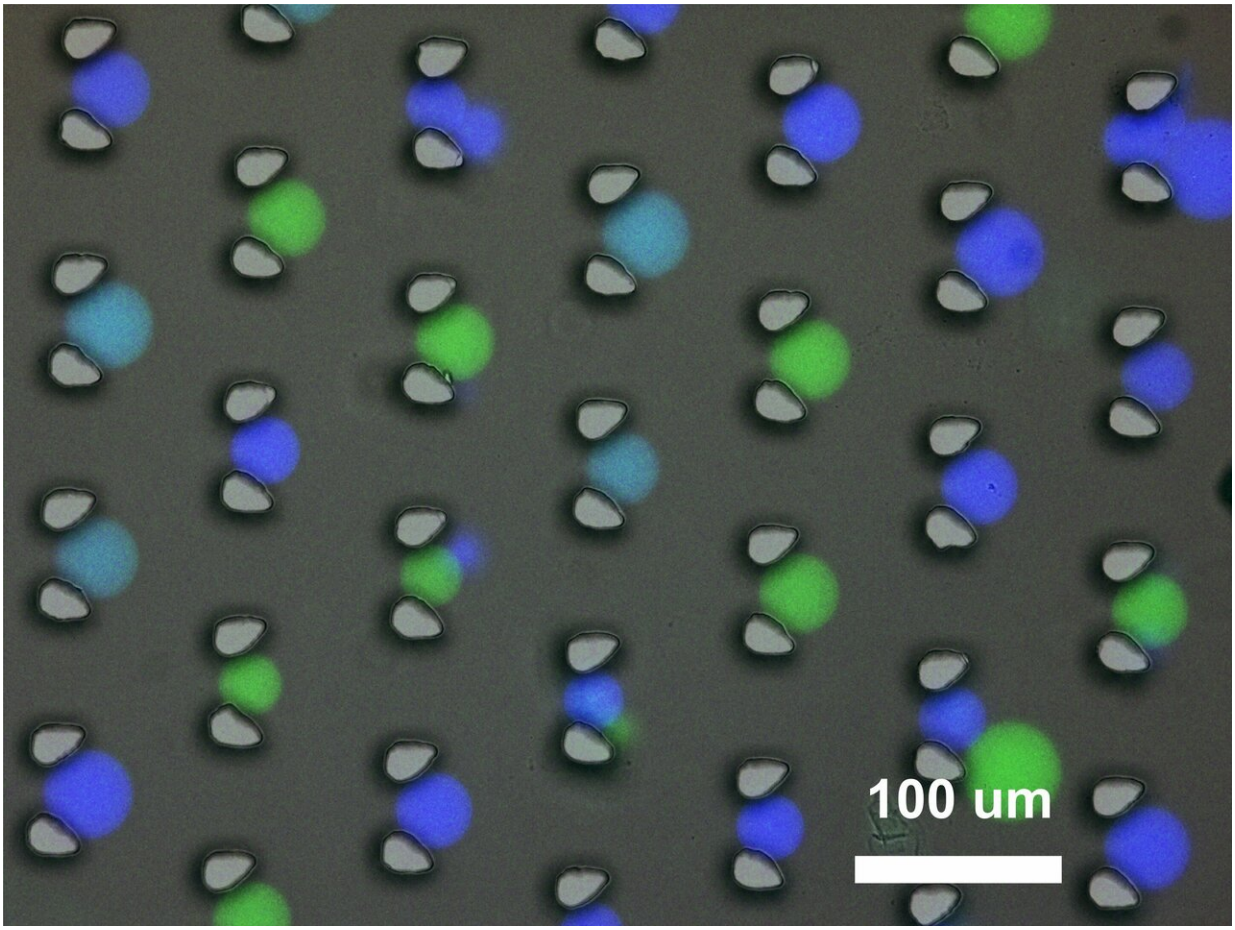

Microscopy image showing green, dark blue and blue-labelled synthetic protocells used for DNA communication and computing. The protocells contain DNA logic gates and are trapped between pairs of small pillars (grey objects) in a microfluidic device. Scale bar, 100 μm. Credit: University of Bristol

The work provides a step towards chemical cognition in synthetic protocells and could be useful in biosensing and therapeutics.

Molecular computers made from DNA use programmable interactions between DNA strands to transform DNA inputs into coded outputs. However, DNA computers are slow because they operate in a chemical soup where they rely on random molecular diffusion to execute a computational step.

Assembling these processes inside artificial cell-like entities (protocells) capable of sending DNA input and output signals to each other would increase the speed of the molecular computations and protect the entrapped DNA strands from degradation by enzymes present in blood.

In a new study published today in the journal *Nature Nanotechnology*, a team led by Professor Stephen Mann from the University of Bristol's School of Chemistry and Professor Tom de Greef from the Department of Biomedical Engineering at Eindhoven University of Technology have developed a new approach called BIO-PC (Biomolecular Implementation Of Protocell communication) based on communities of semi-permeable capsules (proteinosomes) containing a diversity of DNA logic gates that together can be used for molecular sensing and computation.

Compartmentalisation increases the speed, modularity and designability of the computational circuits, reduces cross-talk between the DNA strands, and enables molecular circuits to function in serum.

This new approach lays the groundwork for using protocell communication platforms to bring embedded molecular control circuits closer to practical applications in biosensing and therapeutics.

Professor Mann, from the Bristol Centre for Protolife Research, said:

"The ability to chemically communicate between smart artificial cells using DNA logic codes opens up new opportunities at the interface between unconventional computing and life-like microscale systems.

"This should bring molecular control circuits closer to practical applications and provide new insights into how protocells capable of information processing might have operated at the origin of life."

More information: DNA-based communication in populations of synthetic protocells, *Nature Nanotechnology* (2019). DOI: 10.1038/s41565-019-0399-9 , www.nature.com/articles/s41565-019-0399-9

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