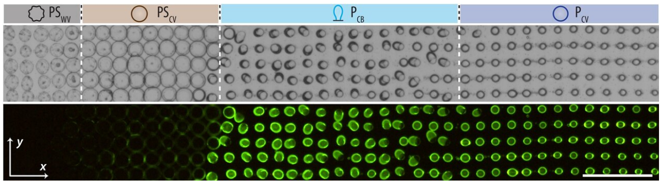
PHYS ORG

# Shape shifting protocells hint at the mechanics of early life

25 July 2019



Optical (top) and fluorescence (bottom) microscopy images of a protocell community showing four protocell types produced spontaneously in an intersecting chemical gradient. Two different artificial morphogens are injected from the left and right sides of the array along the x axis to generate an opposing gradient that translates into different changes in shape, composition and fluorescence in the protocells. Labels for the shape-shifting types are shown in the top row. Credit: University of Bristol

Inspired by the processes of cellular differentiation observed in developmental biology, an interdisciplinary team of researchers at the University of Bristol have demonstrated a new spontaneous approach to building communities of cell-like entities (protocells) using chemical gradients.

In a new study published today in the journal *Nature Communications*, Professor Stephen Mann from Bristol's School of Chemistry, together with colleagues Dr. Liangfei Tian, Dr. Mei Li, and Dr. Avinash Patil in the Bristol Centre for Protolife Research, and Professor Bruce Drinkwater from the Faculty of Engineering used a chemical gradient to transform a uniform population of small droplets into a diverse community of artificial cells.

The team first used ultrasonic waves to create regular rows of thousands of droplets containing the energy storage molecule ATP. They then allowed shape-shifting molecules (artificial morphogens) to diffuse in one direction through the population.

As the morphogens came into contact with the droplets, the droplets transformed row by row into membrane-bounded protocells with different shapes, chemical compositions and enzyme activities. How the droplets changed was dependent on the local morphogen concentration in the advancing chemical gradient.

Waves of differentiation were seen to travel across the population, leaving a pattern of differentiated protocells such that a complex and ordered community emerged spontaneously from the homogeneous population.

Professor Mann said: "This work opens up a new horizon in protocell research because it highlights the opportunities for spontaneously constructing protocell communities with graded structure and functionality.

"Although the research is just beginning, the results provide a step towards developing artificial cell platforms for chemical sensing and monitoring under non-equilibrium (flow-based) conditions."

Dr. Tian added: "As droplet-based protocells have been proposed as plausible progenitors to membrane-bounded protocells on the early Earth, our work could have implications for contemporary theories of the origin of life.

"In particular, as chemical gradients produce protocell diversity from uniform populations, maybe a similar mechanism was responsible for the emergence of functional complexity in ancient proto-living systems."

Provided by University of Bristol