Cellular Construction Methods Emulated

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Not only is our body made of individual organs, our cells themselves are made of tiny organelles, a variety of separate compartments that fulfill different tasks. Such functional, nanostructured systems would also be useful for technical applications, such as biosensors, self-repairing materials, optoelectronic components, or nanocapsules.

However, it has not been possible to recreate structures with sufficient complexity in the lab. Researchers in the Netherlands, led by Jan van Esch at the Universities of Delft and Groningen as well as the BioMaDe Technology Foundation, are now pursuing a new angle.

As they report in the journal *Angewandte Chemie*, they allow surfactants and gelators to form aggregates. These aggregates coexist without interfering with each other and thus make versatile, highly complex structures with separate compartments.

Cells contain various components, such as channels, “motors”, structural frameworks (cytoskeleton), and “power plants” (mitochondria). In order for these to form, their building blocks, mainly proteins and lipids, must “recognize” each other and form the correct assembly by self-aggregation.

In addition, it is critical that compatible components do not separate into different phases: when proteins fold, the water-loving (hydrophilic) and water-repellent (hydrophobic) parts of the molecule stay far away from each other and aggregate with “like-minded” components. Biomembranes are formed when many small lipid molecules aggregate

such that their hydrophobic “tails” face inward together and their hydrophilic “heads” point outward toward the aqueous medium.

The Dutch team imitated this concept by using two types of self-aggregating compounds: surfactants and gelators. Like the lipids in natural membranes, surfactants have a hydrophilic segment and a hydrophobic segment and aggregate into structures such as membrane-like double layers or vesicles (bubbles).

To imitate the forces involved in protein folding—hydrogen-bridge bonds and hydrophobic interactions—the team used a disk-shaped gelator, in which hydrophobic and hydrophilic molecular components alternate in concentric rings. Just as for proteins, like attracts like. This causes the disks to stack together into columns, which forms long fibers, generating a three-dimensional network in the solution to make a gel.

The researchers allow their surfactants and gelators to aggregate together. In this process, the different components take no notice of each other. This independent formation of different supramolecular structures within a single system is called orthogonal self-aggregation. This results in the formation of novel, complex, compartmentalized architectures, for example, interpenetrating but independent networks or vesicle configurations that coexist with gel fibers.

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