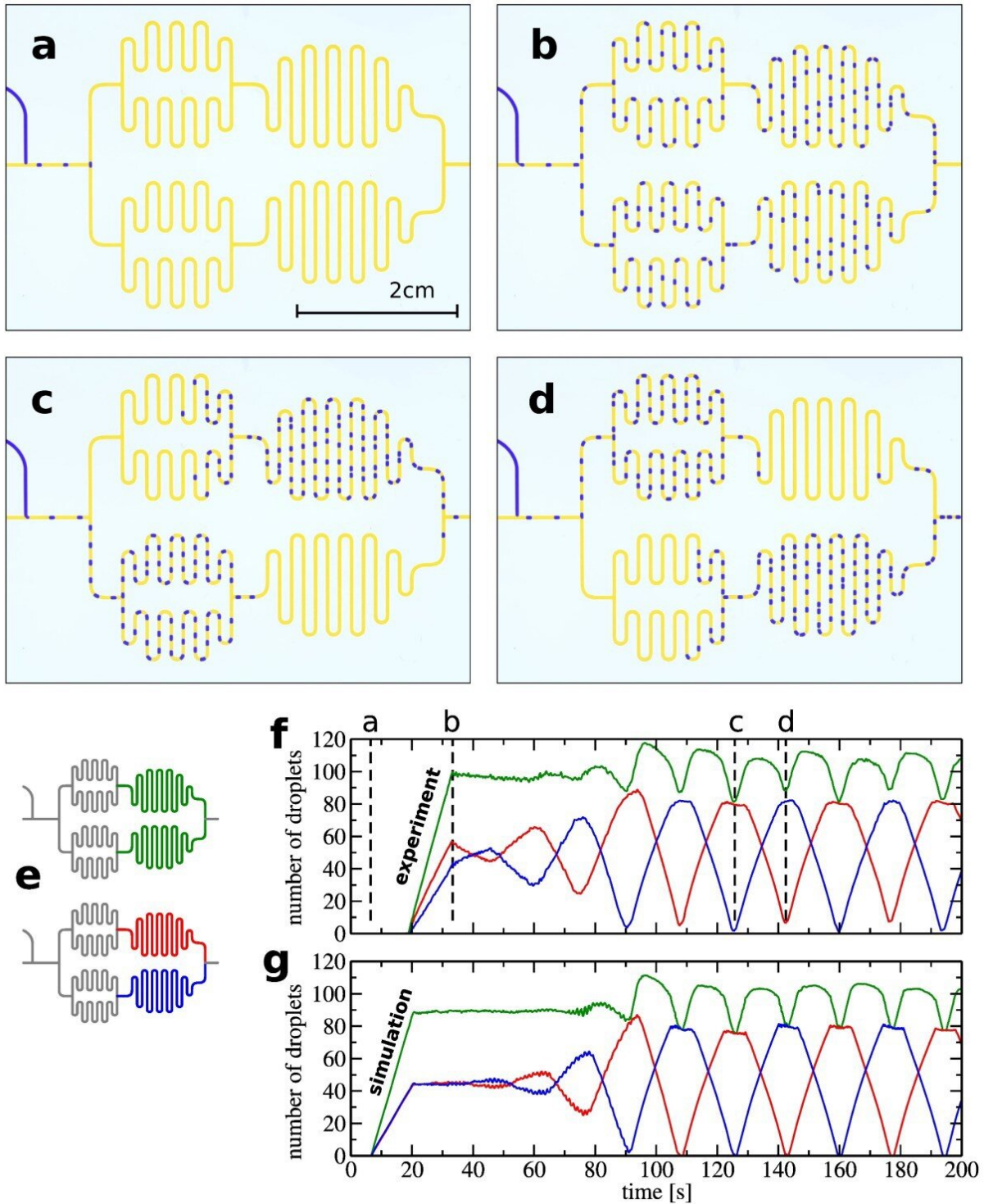


# **Droplet trains reveal how nature navigates blood traffic**

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In the experiment, droplets initially spread themselves uniformly in the network. (Fig. 1b) As time goes by, they slowly organize into a flock (Fig. 1c-d). This explains the mechanisms of the persistent oscillation in blood capillary, which

was found almost a hundred year ago. Credit: IBS

Nearing a decision point, online traffic maps recommend a less-crowded route over the other ways with several slow spots. For most of us, the choice seems clear. Still, have you ever wondered whether this collectively preferring one path may result in a new traffic jam along the chosen road? Indeed, traffic congestions constantly change as the accumulation of drivers' preferences for the "faster path" create new problems. These alternating groups in a system are called a network oscillation. From roadways to computer cable routers and blood vessels, our life is woven in networks of networks. Oscillation is an ubiquitous phenomenon of networks, which are characterized by sets of nodes and paths to choose.

Scientists at the Center for Soft and Living Matter, within the Institute for Basic Science (IBS) in South Korea, in collaboration with the Polish Academy of Sciences (PAN), report that they discovered spontaneous oscillations in microfluidic droplet networks. The scientists have successfully modeled network channels similar to our [blood](#) capillaries in the simplest way containing one or two loops. They also suggest that collision between [blood cells](#) and irregularity of thickness can dampen oscillations in the biological networks. This study can help us understand the emergence and corresponding behavior of the oscillations of blood flow in microvascular networks.

Recognized for its potential for processing samples in isolated droplets through micro-channels, microfluidics is one of the most promising fields for new scientific experiments and innovations. Despite such potential, previous microfluidic studies are limited to simple channels where such [oscillation](#) would not have been present. The IBS scientists have designed a novel experimental system to investigate droplet traffic

in intricate networks. Comprising different branches each with internal loops, the microfluidic networks are in a symmetric shape so that each branch has an equal probability to be chosen by droplets. (Fig. 1a)

In the experiment, droplets initially spread themselves uniformly in the network, just like long chains of train cars moving at regular intervals. (Fig. 1b) As time goes by, they slowly organize into a flock, as if being clogged on that branch while leaving the other branch clear. This flocking oscillates periodically between the two main branches (Fig. 1c-d). Dr. Olgierd Cybulski, the first and co-corresponding author of this study said, "We have proven that this oscillation is a persistent and self-sustaining phenomenon in microfluidic networks. Even when a network's dimensions and topologies varied, the spontaneous oscillations were consistently found. This explains the mechanisms of the persistent oscillation in blood capillary, which was discovered almost a hundred year ago."

Strikingly, this study demonstrates how this persistent oscillation is regulated by nature. Large-scale oscillations in vascular networks may cause an imbalance of blood flow, resulting in high blood pressure and deprivation of oxygen. The researchers found that adding a random variable to a network through computer simulation relieves blood traffic congestion. This suggests that irregularities of blood flow such as cell collisions or diameter varieties help us to avoid dangerous oscillations in a microvascular network.

"This study reveals the mechanism of microfluidic networks, enhancing our understanding on [blood capillaries](#)," explained Bartosz Grzybowski, a group leader of the IBS center and co-corresponding author of the study. "Learning from nature, man-made [microfluidic](#) systems will provide a new platform to split and merge droplets in the future, using [network](#) oscillations," he adds.

The study is published in *Nature Physics*.

**More information:** Olgierd Cybulski†, Piotr Garstecki, Bartosz Grzybowski†. Emergence of oscillating droplet trains in microfluidic networks and their suppression in blood flow. *Nature Physics*. [DOI: 10.1038/s41567-019-0486-8](https://doi.org/10.1038/s41567-019-0486-8)

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