Scientists propose a new model for the specialization of cells

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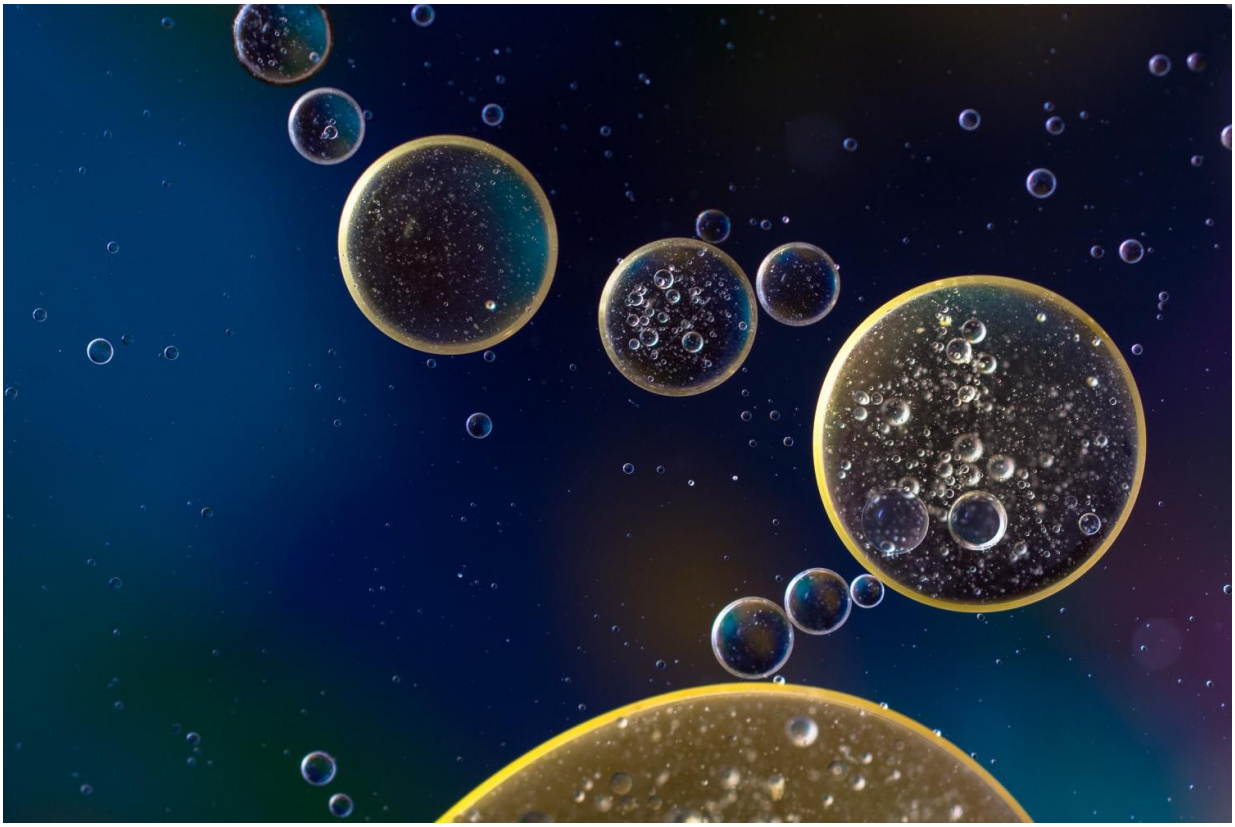

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Mathematicians at the Higher School of Economics have developed a model that explains how cell specialization arises in the context of resource constraints. The results are published in *PLOS ONE* journal.

The division of labour and the functional specialization of cells are manifested at different levels cellular organization. Even in simple multicellular organisms (e.g., cyanobacteria, mycobacteria, multicellular yeast), specialization of two types can be observed: somatic, when cells are responsible for viability, and reproductive, when cells are responsible only for reproduction. The question of how the specialization of cells occurs is of interest not only for biologists, but also for mathematicians who build models of biological processes. However, many models of specialization used in evolutionary biology to describe the processes that take place in the simplest multicellular organisms have a number of shortcomings. For example, they do not take into account the influence of the environment on the system.

In an article titled "Modeling functional specialization of a cell colony under different fecundity and viability rates and resource constraint," scientists from the Higher School of Economics and the University of Quebec in Montreal proposed a model that explains the conditions under which cellular specialization arises under resource constraints.

One of the most common models today belongs to Richard Michod. It assumes that identical cells demonstrate the same degree of viability and fecundity. "This ideal distribution of cells is difficult to imagine in living systems. In addition, the system cannot exist in isolation because it is always influenced by the environment," says Fuad Aleskerov, professor at the Higher School of Economics. "Our model shows that in terms of resource constraints, specialization happens so as to help the entire body be more efficient under current environmental parameters."

Researchers considered a model in which a different amount of resources is required to perform somatic and reproductive functions (for simplicity, sunlight is treated as a resource).

Suppose that in order to perform a somatic function, the body needs 1

joule (J), while to perform the reproductive function, 5 J are necessary. The input from the external environment is 4 J. In this situation, the cells will specialize in such a way that ensures that the entire system works effectively. The number of cells responsible for viability will increase since they need less energy. To what extent this model corresponds to reality remains a question for biologists to verify.

In addition to considering general resource constraints, the proposed model takes into account other aspects of the biology of protozoan multicellular organisms, says Denis Tverskoy, a postgraduate student at the Higher School of Economics. In particular, the model considers the parameters of the importance of reproductive and somatic functions for the effectiveness of organisms. Biological experiments show that in some types of environments the somatic function may be more important than in others. In addition, the model allows for the possibility of initial differentiation of cells, which occurs at the stage of embryonic development as a result of the work of special regulatory genes or external chemical stimuli.

More information: Denis Tverskoi et al, Modeling functional specialization of a cell colony under different fecundity and viability rates and resource constraint, *PLOS ONE* (2018). DOI: 10.1371/journal.pone.0201446

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