Embracing idiosyncrasies over optimization: The path to innovation in biotechnological design

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Sometimes sparks of innovation require taking the path less well trodden. Credit: Thomas Gorochowski

Scientists working on biological design should focus on the idiosyncrasies of biological systems over optimization, according to new research.

In a study, published in *Science Advances*, researchers from the Universities of Bristol and Ghent have shown how exploring the unknown may be the crucial step needed to realize the continual innovation needed for the biotechnologies of the future. The paper is titled "Open-endedness in synthetic biology: a route to continual innovation for biological design."

Recognizing the role of open-endedness in achieving this goal and its growing importance in fields like computer science and evolutionary biology, the team mapped out how open-endedness is linked to bioengineering practice today and what would be required to achieve it in the lab.

For success, algorithms used for biological design should not solely focus on moving toward a specific goal—such as better yield—but also consider the creation and maintenance of novelty and diversity in the solutions that have been found.

Dr. Thomas Gorochowski, co-author and Royal Society University Research Fellow in the School of Biological Sciences at Bristol, said, "When we try to design a complex biological process, it's often tempting to just tweak something that partially works rather than take the risk of

trying something completely new.

"In this work we highlight that in these situations the best solutions often come from unexpected directions, because we don't always fully understand how everything works. With biology, there are lots of unknowns and so we need a vast and diverse toolkit of building blocks to ensure we have the best chance of finding the solution we need."

Professor Michiel Stock, lead author from Ghent University, added, "Biological systems have a natural capacity for innovation that has led to the overwhelming biodiversity we see in nature today.

"Our own attempts to engineer biology, in contrast, lack this creativity—they are far more rigid, less imaginative, and often [don't] make the best use of what biology is capable of.

"With all life around us originating from the open-ended process of evolution, wouldn't it be awesome if we could harness some of that power for our own biological designs."

The ability to create new biotechnologies is becoming increasingly important for tackling global challenges spanning the sustainable production of chemicals, materials and food, to advanced therapeutics to combat emerging diseases. Fueling this progress are innovations in how biology can be harnessed in new ways. This work supports this goal by offering a fresh direction for new research and design approaches.

More information: Michiel Stock et al, Open-endedness in synthetic biology: a route to continual innovation for biological design, *Science Advances* (2024). DOI: 10.1126/sciadv.adi3621. www.science.org/doi/10.1126/sciadv.adi3621