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European Commission

Science for Environment Policy

Synthetic biology: built-in barriers could prevent interactions with natural biology

A recent analysis highlights advances in the field of synthetic biology and efforts to develop approaches that will prevent non-natural organisms from interfering with natural organisms and ecosystems. It suggests that synthetic organisms could be developed with inbuilt 'firewalls' that prevent genetic interactions with other organisms.

Synthetic biology is a rapidly emerging area of science that explores how natural systems could be simplified and amended, using an engineering approach. It seeks to design biological systems that do not exist in nature, or to re-design existing ones, to gain a better understanding of biological processes, generate and assemble functional components, and develop novel applications or processes. Synthetic biology is expected to have applications in many different domains, including industrial biotechnology, health, energy and the environment. For environmental applications, the potential of synthetically-engineered bacteria to monitor pollution, clean up contaminated sites and improve biodiesel production, among other uses, is currently being explored.

The researchers, partly-funded under the EU METACODE project[1], discuss possibilities for biosafety and novel forms of containment in both genetic engineering and synthetic biology. Studies have shown that DNA from genetically modified organisms (GMOs) persists outside the laboratory, as has been observed with creeping bentgrass in the US and in Mexican maize. As with GMOs, concerns have been raised about the impacts on the environment if synthetically-produced agents were to 'escape' and interact with natural biological forms.

To prevent this interplay between natural and artificial biology, the study suggests that synthetic agents could be assembled using a genetic code that is non-understandable to DNA-based organisms. Alternatives to DNA, such as XNA, which store genetic information, are the subject of ongoing research.

XNA performs the same function as DNA, but, according to the authors of the study, the genetic information it stores should be invisible to organisms based on DNA. Further development of XNA is needed to ensure this. If confirmed and fully realised, new forms of genetic material, such as XNA, should then potentially have no effect on the genomes of natural organisms. This is in contrast to genes from transgenic sources that can, for example, be readily taken up by microbes. The researchers term this separation of synthetic and natural agents the 'genetic firewall'.

Risks associated with uncontained GMOs in the environment have been closely scrutinised in Europe and the US, and the researchers suggest that this large body of work is used to frame the discussion of the health and environmental risks related to synthetic biology.

There is an increasing awareness among synthetic biologists of the need to interact in a responsible and fair manner when communicating their work to the public and the media. The synthetic biology community must also be sensitive to the need to respond to feedback from other scientists and non-scientists alike, the study suggests. Via the Seventh Framework Programme for Research, the European Commission has funded various actions to promote such responsible action in synthetic biology, encouraging scientists to engage with the public and to pay particular attention to the biosafety, ethical and governance aspects of their work.