European Parliament

The DNA revolution: We better talk this over

Powerful new tools that have emerged in recent years have rendered DNA-editing technology more precise, more accessible and more affordable, allowing it to find new applications in fields such as medicine, agriculture, and energy. With its top-class academic institutions and strong biotechnology research, Europe is a driving force behind this 'synthetic biology revolution'. However, this innovative technology also poses serious risks arising from the unintended or intended effects of its use, and raises ethical concerns about the potential modification of the human genome. Can we minimise these risks, while enjoying the benefits of this new technology?

What is the DNA revolution?

Genetic engineering has made huge strides in the past five years, one such example being a technique widely known as CRISPR. Available since 2013, it acts as 'molecular scissors' that make it possible to edit the genome more precisely, by cutting and pasting DNA. It is part of the emerging field of synthetic biology, the deliberate design of biological systems and living organisms achieved through the use of engineering principles. Using DNA-editing technology has become easier, more affordable and more widely accessible. With gene-editing toolkits now available for less than €100, their use in research, industry and citizen science initiatives has become widespread. The combination of DNA editing with artificial intelligence, automation, DNA printing and 'lab on a chip' devices is revolutionising the development and manufacture of engineered organisms. In 2016, more than US$1 billion was invested in synthetic biology, and the market is growing rapidly. Europe is at the forefront of synthetic biology research, having world-class institutions such as the European Molecular Biology Laboratory and the European Bioinformatics Institute. An estimated 150 European companies work on synthetic biology research and on developing applications based on it.

Uses of synthetic biology

Synthetic biology can be used in a range of beneficial but also nefarious ways. Most commercial ventures focus on creating micro-organisms (such as bacteria, yeast and algae) that synthesise valuable products, including pharmaceuticals, food and fuels. It is possible to develop organisms that purify water by removing pollutants. Biofuels produced by engineered algae could be a climate-friendly energy source that does not require agricultural land. Synthetic biology can create new crop varieties resistant to pests or having enhanced nutritional properties. In medicine, the targeted treatment of cancers is yet another promising application. Synthetic biology could help to re-create extinct species, but also deadly threats like smallpox.

Risks and challenges

The cross-cutting and diffuse nature of synthetic biology makes tracking, regulating or mitigating potential biosafety and biosecurity risks a very difficult task. Synthetic biology can make it easier for states and terrorists to develop biological weapons. Engineered organisms released into the environment can have irreversible effects on biodiversity and ecosystems, and unintended effects if genes are transferred to wild populations. 'Gene drives' that cause DNA modifications to spread rapidly have the potential to alter or extinguish entire populations.

The rapid pace at which synthetic technology is developing challenges regulators and policy-makers to come up with rules ensuring it is used safely and with no unacceptable risks. Modifications of the germline that are passed to future generations are of particular concern. Chinese researchers have used CRISPR on human embryos, sparking controversy and prompting calls for a ban on such experiments. If we treat biology as a machine, our entire relationship with nature is called into question.

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