The Norwegian Academy of Science and Letters has decided to award the Kavli Prize in Nanoscience for 2018 to

Emmanuelle Charpentier

Max Planck Institute for Infection Biology, Berlin, GERMANY

Jennifer A. Doudna

University of California, Berkeley, USA

Virginijus Šikšnys

Vilnius University, LITHUANIA

"for the invention of CRISPR-Cas9, a precise nanotool for editing DNA, causing a revolution in biology, agriculture, and medicine."

To repair a defect in the genome of an organism, one would have to remove, alter, or insert a genetic code at atomically precise locations in the DNA sequence. This vision is now a reality with CRISPR-Cas9, a nanotool that opens a door towards curing hereditary diseases and boosting agriculture. CRISPR-Cas9 constitutes a revolutionary innovation compared to prior techniques, which were tedious, imprecise, and costly.

CRISPR-Cas9 is simple to use. A small RNA molecule is synthesized to encode the address of the DNA sequence to be altered. This RNA molecule is attached to a Cas9 protein to form a CRISPR-Cas9 complex. The complex attaches to the target DNA. Cas9 then opens and cleaves the DNA at exactly the desired location. As the DNA segments reconnect, genes may be inserted or defunctionalized. In this way, disease-causing mutations can be corrected by changing the underlying genetic code. CRISPR-Cas9 works on many organisms, including plants, fungi, animals, and humans.

The breakthrough of CRISPR-Cas9 builds on the discovery and exploration of CRISPR. CRISPR stands for "clustered regularly interspaced short palindromic repeats," a DNA base-pair sequence used by the immune system of bacteria against viral attacks. With their teams, Emmanuelle Charpentier and Jennifer A. Doudna, and independently Virginijus Šikšnys invented a way to develop CRISPR and Cas9 into a powerful nanotool. Their pioneering work and further great advances by a growing number of researchers continue to unleash the enormous potential of CRISPR-Cas9.

This great invention not only offers tremendous opportunities but also carries responsibilities and risks that affect all humankind. Profound ethical challenges must be addressed and resolved.

CRISPR-Cas9 confers to society enormous capabilities for positive innovations. Possible benefits are wide-ranging in scope and value. From a fundamental perspective, CRISPR-Cas9 is a breakthrough nanotool for research in the life sciences that will greatly enhance our understanding of genetic mechanisms. It enables the detailed study of many hitherto genetically intractable organisms. Potential applications of CRISPR-Cas9 are to optimize agriculture with regard to breeding crops and livestock having desired properties. Potential medical applications include the capability of correcting disease-causing mutations and using gene therapy to cure serious diseases such as muscular dystrophy, sickle-cell anemia, and some forms of blindness and cancer.

The CRISPR-Cas9 nanotool initiates a revolution in genetic engineering with great potential benefits and pressing ethical challenges.