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What are some of the most exciting potential applications of CRISPR/Cas9?

For basic research it opens completely new opportunities. We can now manipulate the genome in almost any possible way. Sequences can be removed, changed, or inserted. This allows us to investigate the biology of genomes in a much more effective manner. Genome editing is now widely used to investigate variants of the genome and to test the potential pathogenicity, i.e. whether or not they cause a disease. Also, questions that could not be addressed before can now be tackled in a comprehensive and efficient way. For example, CRISPR/Cas9 is now used to screen the entire genome for genes that are important for certain biological functions.

Some very exciting potential applications are the use of CRIPSR/Cas9 in gene therapy. Hopefully genome editing can be used to inactivate or correct certain mutations that, for example cause hereditary diseases or cancer. Conditions that affect blood production, such as sickle cell anemia, thalassemia, or cancer of the white blood cells could be cured if stem cells can be treated with CRISPR/Cas9 to remove the pathogenic mutation. Likewise, resistance to HIV could be induced by a mutation; thereby supplying an affected individual with resistant cells.

CRISPR/Cas9 provides enormous potential for its application in plants and livestock. The accurate editing of genomes now makes it possible to change any genome. This has induced crops to resist attacks by harmful insects, fungi, and plant diseases, or produced animals with certain desired features.

What are some of the ethical and safety issues associated with this technology?

CRISPR/Cas9 is a genome editing technology like others that have been used in the past, but it is much more effective. Thus, the ethical and safety issues are not fundamentally different from technologies that have been used in the past. It is clear, however, that the dimensions are completely different and that genome editing will affect how we will live in the future. It has to be decided if and how

genome editing of plants and livestock with CRISPR/Cas9 or any other related technologies will be classified. A major concern within the scientific community and beyond is related to genome editing in human embryos. The possibility that CRISPR/Cas9 can be used to change the human genome in a way that will be passed on to future generations is viewed by many as a threat. Others point out that certain diseases might be curable if treated by genome editing in the embryo.

What are the biggest questions yet to be answered by CRISPR?

The applications for CRISPR are extremely wide and new ones are developed constantly. I think that we can expect many surprises in the near future.

Please elaborate on one or two of your current research projects that focus on CRISPR/Cas9.

We use CRISPR/Cas9 as a tool to manipulate the genome. We want to understand how a certain class of mutations, known as structural variations, can affect the genome. In particular, we want to study how such changes can induce disease and how their effects can be predicted. This is also important for diagnostic purposes. In addition, we use the technology to better understand how genes are regulated during development. The regulation of our ~20,000 genes is an intricate and extremely important process that is not well understood. We remove and add certain sequences in the genome to investigate their role in gene regulation.