## Titel des Themas

Genetic Engineering in Modern and Future Societies

## Schlagworte

Gene editing; gene therapy; genetically modified organism; ethical implications; societal implementation

## Kurzfassung des Themas

Since the discovery of the gene editing technology CRISPR-Cas, genetic engineering advances at unprecedented rates yielding exciting breakthroughs for the treatment of previously untreatable diseases. First clinical trials leveraging the newest gene editing technologies are ongoing and the approval of the very first gene editing-based therapeutic is expected within the next few months. Similarly, the approval of the first siRNA-based drug Onpattro® in 2018 and the COVID-19 mRNA vaccines in 2020 have catapulted humanity into the next era of precision medicine. In addition, genetic engineering further has the potential to revolutionize reproductive and preventive medicine, something that would have huge, yet unknown societal implications. Genetic engineering also affects areas beyond medicine including food production, plant breeding, and livestock production more specifically. In the US, the first CRISPR-edited salad is now being marketed. Here, the spiciness of the plant has been reduced by genetic engineering while retaining its nutritional content. The societal impact of such applications is enormous as nutrition affects everyone. Genetic engineering is a major technology of the future that eventually will affect everyone's daily lives. Just recently, we witnessed how controversial and highly emotional discussions around emerging technologies such as the COVID-19 mRNA vaccines can become highlighting the importance of addressing this next grand challenge.

## a) Inwiefern stellt das Thema eine globale Herausforderung von hoher aktueller und zukünftiger gesellschaftlicher Relevanz dar?

Genetic engineering causes a lot of excitement, especially in North America and Asia, where primarily the potential benefit of this technology is seen. Germany is much more reluctant and in a wait-and-see position. While genetic engineering has the potential to transform the lives of billions of people, these are still relatively new technologies whose potential risks and societal implications are poorly understood. This starts with potential off-target effects when correcting a disease-causing mutation. A potential risk is that off-target regions are edited which might promote tumor growth. Although initial studies show a great target specificity, it remains unclear as to what percentage can be tolerated. Other aspects go beyond treating life-threatening conditions, for example in reproductive medicine. Genetic engineering now provides us with the tools to edit the genome of unborn fetuses, something that is often discussed as the creation of designer babies. This ultimately poses the question of how far we want to go as a society. Also, the world population is growing fast, even today many people do not have access to sufficient food supplies which will be further aggravated by the imbalanced wealth distribution and climate change. By genetically engineering more robust or profitable crops and more resilient livestock, we could alleviate the food supply problem.

Yet, potential long-term risks are unknown which requires orchestrated efforts to address these challenges.

## b) Welches wissenschaftliche Erkenntnisinteresse wird aufgegriffen und ist anschlussfähig für exzellente, internationale Forschung?

Genetic engineering is a powerful tool to prevent, treat, and cure a multitude of human diseases. The first gene therapy, Glybera®, obtained regulatory approval in 2012 and at least nine more followed since then. Currently, drug development pipelines and clinical trials are full of genetic engineering approaches that hold high hopes for the treatment of previously untreatable conditions. The discovery of CRISPR-based gene editing in 2012 significantly accelerated the genetic engineering field and resulted in the Nobel Prize just eight years later. Since its discovery, CRISPR-based gene editing has been continuously advanced resulting in even more sophisticated approaches, such as prime editing or base editing. Initial clinical trials are ongoing and very encouraging initial results have been released. As detailed before, genetic engineering not only revolutionized the life sciences but also directly impact many other areas of high societal relevance such as agriculture and food production. Building onto the recent advances, several key tasks remain: (1) Develop safe and efficient engineering strategies, (2) unravel potential side and long-term effects, (3) translate the findings from bench-to-bedside or from academia to a societal benefit, and (4) define boundaries and inform/educate the society.

## c) Inwieweit ist das Thema durch die Expertise der Berliner Wissenschaft und Gesellschaft inter- und transdisziplinär bearbeitbar und/oder lösbar?

A unique selling point of Berlin is its multi-disciplinary scientific landscape that puts Berlin at the forefront of basic, translational, and clinical research. At the different BUA institutions and collaborating institutions, excellent basic and clinician scientists are already working toward enabling gene and cell-based therapies for orphan and other life-threatening diseases including cancer. Beyond the research in life sciences, Berlin houses several working groups that are exploring potential ethical implications of genetic engineering in the healthcare sector and beyond from different angles. Complementarily, social scientists are studying biotechnology in a social context by conducting technology impact assessments. In addition to its academic excellence, Berlin is a thriving entrepreneurial environment with interests in genetic engineering ranging from early-stage spin-off companies to global players such as the Bayer AG. The latter just signed an agreement with the Charité to work together in the field of cell and gene therapy. Another asset is the close proximity to key stakeholders in education, legislation, and the healthcare sector such as insurance providers and federal ministries. Taken together, this positions Berlin very well for addressing genetic engineering as one of the next grand challenges of our society. This topic would also strengthen Berlin’s role as a pioneer in that area as we are not aware of similar efforts in Germany outside of Berlin.

Welche weiteren, bislang noch nicht genannten, Argumente sprechen für Ihr Thema?

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