Human Bioengineering: Balancing innovation, ethics, and public health

Welcome delegates to the United Nations World Health Organization of SharkMUN 2026.

In this committee, delegates will address a frontier of modern science that is ethically complex and has grown rapidly: human bioengineering. Rapid advances in genetic editing, synthetic biology, and biotechnology are causing unprecedented possibilities for eliminating hereditary diseases, extending life expectancy, and enhancing human capabilities. However, these same technologies raise profound questions about consent, equity, biosafety, and the boundaries of what it means to be a human.

Delegates will examine how emerging bioengineering technologies are developed and applied across the world, and evaluate the public health, ethical, and regulatory challenges they present. The committee must also consider risks of unequal access, exploitation, and the potential for irreversible consequences if bioengineering is pursued without adequate international oversight.

The World Health Organization serves as a coordinator and director of authority on international public health. Delegates are encouraged to develop inclusive, ethically, and scientifically informed solutions to ensure that human bioengineering advances the health of all people, rather than deepening existing inequalities.

Introduction

Human bioengineering refers to the application of scientific and engineering principles to modify, enhance, or repair biological systems of the human body. From early gene therapy experiments to the recent emergence of CRISPR-Cas9 gene editing technology, bioengineering has evolved from a theoretical frontier into rapidly developing medical and scientific reality.

At its most promising, human bioengineering offers the potential to cure previously untreatable different genetic conditions, eliminate hereditary diseases in families lines, repair damaged tissues and organs, and enhance the human immune system's ability to combat infectious systems.

However, the same tools that offer therapeutic promise also include and present serious risks. The modification of germline cells, sperm, eggs, and embryos produces heritable changes that are passed to ongoing generations, raising serious questions about consent, long-term safety, and the alteration of the human gene pool. In 2018, the birth of the first gene-edited babies in China shocked internationally the scientific community and exposed the absence of effective global governance frameworks.

Beyond genetic editing, human bioengineering encompasses neural interfaces, synthetic organ development, enhancement technologies, and the emerging field of synthetic biology. Each of these domains introduces unique risks related especially to safety, access, dual-use potential, and the ethical limits of human modification.

Key terms

Human Bioengineering

The application of engineering and scientific principles to modify, repair, or enhance the biological systems of the human body, including genetic, cellular, and psychological interventions

CRISPR-Cas9

A molecular tool that allows scientists to precisely edit DNA sequences with living organisms, enabling targeted modifications to the human genome.

Germline Editing

Genetic modifications made to reproductive cells or embryos that are heritable and can be passed to future generations.

Synthetic Biology

An interdisciplinary field that applies engineering principles to the design and construction of new biological parts, devices, and systems.

Dual-Use Research

Scientific research that has legitimate public health or medical applications but could also potentially be misused to cause harm.

Background Information

Advances in CRISPR technology (and related) gene-editing tools have dramatically accelerated the pace of human bioengineering research. Clinical trials using somatic gene therapies are underway for a growing number of conditions, including sickle cell disease, beta-thalassemia, certain cancers, and inherited forms of blindness. Several therapies have acquired regulatory approval in major markets.

At the same time, the 2018 case of He Jianuki, the Chinese researcher who created the first gene-edited human babies, revealed the risks of inadequate oversight. His experiment was widely condemned by scientists and ethicists as premature, dangerous, and ethically unjustifiable. The incident prompted international calls for stronger governance frameworks but has not yet produced a binding global agreement.

Private investment in bioengineering and synthetic biology has grown significantly, with biotechnologies companies and start-ups operating across diverse regulatory environments. This creates the risk that research or clinical applications prohibited in one country may continue in jurisdictions with a weak oversight.

Equity concerns have been raised and are also central to the current situation. Advanced bioengineering therapies are often prohibitively expensive, with some genes costing millions of dollars only for one treatment. This raises the prospect of a world in which biological enhancement or even life saving genetic treatments are accessible only for wealthy countries and individuals. International regulatory frameworks have yet to meaningfully address these technologies.

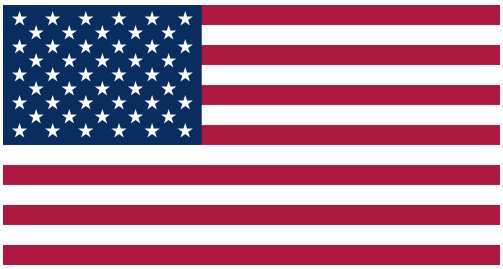
Main Countries Involved

China

China has emerged as a major force in bioengineering research and has invested heavily in genomics and synthetic biology. The He Jiankui affair highlighted gaps in regulatory enforcement, and China has since updated its bioethics regulations. However, concerns remain regarding transparency and alignment with international standards.

United States of America

The United States is a global leader in bioengineering research and biotechnology investment. Federal agencies such as the FDA and NIH regulate gene therapy trials, though private sector activity operates across a complex regulatory landscape. The US has been active in international discussions on bioethics and germline editing governance.

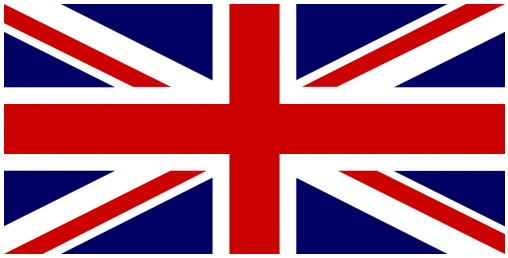


Germany

Germany maintains strict regulations on genetic modification and embryo research, rooted in the post-World War 2 legal and ethical framework. It advocates for strong international governance germline editing and enhancement technologies.

United Kingdom

The UK has one of the world's most developed regulatory frameworks for embryo research and has permitted mitochondrial replacement therapy under strict conditions. It plays an active role in shaping international bioethics norms.



Previous attempts to solve the issue

The international community has several attempts to establish ethical and regulatory frameworks for human bioengineering, though a binding global treaty remains absent. The UNESCO Universal Declaration on the Human Genome and Human Rights, adopted in 1997, affirmed that the human genome is the common heritage of humanity and called for protections against practices contrary to human dignity.

The Council of Europe's Oviedo Convention on Human Rights and Biomedicine prohibits germline modifications intended to be heritable, making it the only legally binding international instrument directly addressing this issue, though it has not been ratified by many major states.

The World Health Organization established an Expert Advisory Committee on Human Genome Editing in 2019, which published a governance framework in 2021 recommending the creation of a global registry of human genome editing research and calling for international coordination of regulatory standards.

Multiple international summits on human gene editing have been convened by scientific academies in the United States, United Kingdom, and China, producing consensus statements urging caution on germline editing and calling for responsible scientific conduct. Despite these efforts, enforcement mechanisms remain absent, and private and national research programs continue to advance rapidly.

Possible solutions to the issue

1. **International Framework for the Regulation of Germline Gene Editing**

   Establishing an international treaty or binding framework governing germline gene editing and prohibiting non-therapeutic human enhancement without informed consent.

2. **Global Registry for Human Bioengineering Research**

   Creating a global registry of human bioengineering clinical trials and research programs under WHO oversight to ensure transparency and accountability.

3. **International Ethical and Regulatory Standards for Bioengineering**

   Developing international minimum standards for the ethical review and regulatory approval of gene therapy and bioengineering interventions.

4. **Equitable Access to Bioengineering Therapies**

   Expanding access to safe and approved bioengineering therapies in low- and middle-income countries through technology transfer, funding mechanisms, and tiered pricing.

5. **Capacity-Building for National Regulatory Systems**

   Strengthening national regulatory capacity in developing nations through international technical assistance and capacity-building programs.

6. **International Cooperation on Biosafety and Risk Assessment**

   Promoting international scientific cooperation on biosafety research to assess and mitigate the long-term risks of heritable genetic modifications.

References

Consejo de Europa. (1950). *Convenio para la Protección de los Derechos Humanos y de las Libertades Fundamentales*. https://www.coe.int/en/web/conventions/full-list?module=treaty-detail&treatynum=164

UNESCO. (1997). *Universal Declaration on the Human Genome and Human Rights*. https://www.unesco.org/en/legal-affairs/universal-declaration-human-genome-and-human-rights

World Health Organization. (2021, July 12). *WHO issues new recommendations on human genome editing for the advancement of public health*. https://www.who.int/news/item/12-07-2021-who-issues-new-recommendations-on-human-genome-editing-for-the-advancement-of-public-health

World Health Organization. (2021). *Human genome editing: Recommendations*. https://www.who.int/publications/i/item/9789240030060
Scientific American. (2023, December 8). *FDA approves first CRISPR gene-editing treatment for sickle cell disease*. Scientific American. https://www.scientificamerican.com/article/fda-approves-first-crispr-gene-editing-treatment-for-sickle-cell-disease/

Frangoul, H., Altshuler, D., Cappellini, M. D., Engelhardt, K. R., Galacteros, F., Grupp, S., Handgretinger, R., Ho, T. W., Kattamis, A., Kernytsky, A., Lekstrom-Himes, J., Li, A. M., Locatelli, F., Mapara, M. Y., de Montalembert, M., Rondelli, D., Shenoy, S., Sheth, S., Teachey, D. T., ... Corbacioglu, S. (2021). *CRISPR-Cas9 gene editing for sickle cell disease and β-thalassemia*. *New England Journal of Medicine, 384*(3), 252–260. https://www.nejm.org/doi/full/10.1056/NEJMoa2031054