JejuMUN XII

BACKGROUND GUIDE

World Health Organization

Formulating international standards for the safe and equitable usage of gene editing and CRISPR technologies in global health care

SDG: 3. Good Health and Well-Being

Authored by Jueon Kang, Yejun (Chris) Choi, Chaeyeon (Joey) Yu

November 28th-29th, 2025

Last updated on July 26, 2025

Table of Contents

Committee Introduction

The World Health Organization (WHO) was founded on April 7, 1948, as a specialized United Nations agency for promoting health, securing safety around the world, and serving the vulnerable in society. WHO aims to cover a billion or more people to have a fundamental right to prevent significant outbreaks, be protected with better health, and be provided with a service that can improve their social well-being, not just the absence of disease, giving the teaching and training of maintaining public health, treatment, and related matters. WHO, when in struggle, delivers technical assistance to nations, sets international health standards, and plays a role as a forum for policy discussions mainly about health. They support financial assistance to low- or middle-income countries by giving them housing, shelters, education, and more through other systems.

During the COVID-19 pandemic, the WHO launched the COVAX system, which was programmed to ensure equitable vaccine distribution, supporting over 190 countries with individualized protective equipment and basic resources that can cover their essential needs. Historically, between 1967 and 1980, they had made the greatest achievements: they had initiated the campaign to eradicate smallpox, spreading mass vaccination in high-risk regions such as Africa, South America, and South Asia. Further, they introduced a technique called “ring vaccination” that involves identifying smallpox cases that can isolate them, and then vaccinating all people in close contact with the infected people. Unlike general committees, the WHO is the authorized organization on international public health. They are the only body that can declare a Public Health Emergency of International Concern (PHEIC) and effectively mobilize international resources, funding, and coordination.

Agenda Introduction

Since 2012, gene editing technologies that modify DNA sequences in cells, such as the CRISPR-CAS9 technology, have revolutionized the world's biomedical science in human bodies and genomes. Its technological advancements created opportunities for biomedical science to cure a wide range of diseases, such as but not limited to cancer, genetic diseases, and some cases of infectious diseases. However, based on international guidelines and borders, the CRISPR-CAS9 technology has brought several ethical, legal, and social challenges to the world.

Among 300 million people globally with rare genetic diseases, only some are accessible to gene editing technologies. Over 90% of the genomic studies are taking place in European nations. Furthermore, fewer than 30% of the nations have CRISPR-CAS9 technology and an infrastructure for further research. As the fee for development of such a technology is not as accessible for the developing nations, it creates a healthcare inequality between the nations. However, even inside the developed nations, gene editing treatment such as Hemgenix is known to be priced at $3.5 million for each dose. The United Nations, being at the forefront in the management of global health care, has an obligation to enable more equitable usage of CRISPR-CAS9 technologies for all global citizens.

Additionally, the current CRISPR-CAS9 technology requires further development. Often creating concerns of exploitation of abusive capabilities, the current Gene editing technologies have unintended consequences where off-target gene editing occurs. This raises further concern for the global communities regarding the safety of gene editing technology, but also the further development of such technology.

The United Nations, positioned to manage human rights, has an obligation to create a bridge between scientific development and human rights, ensuring the CRISPR-CAS9 technology becomes a tool for global health care for every global citizen.

Letter from the Chairs

Greetings Delegate, I am Jueon Kang, who will be serving as your head chair for the WHO committee of JEJUMUN XII. I am currently a rising freshman at Korea International School Jeju. I started my Model United Nations Journey two years ago in 2023. Since then, I have participated in 12+ conferences, both as a delegate and a chair. I expect passionate discussions, fruitful debates, and professionalism throughout JEJUMUN XII. Please try to always stay in order and maintain your professionalism throughout the conference. I can proudly say that this will create a better conference for everyone to participate in. Like JEJUMUN X and XI did for me, I hope JEJUMUN XII becomes an important milestone in your MUN career.

Greetings delegates! My name is Chris Choi, and I am pleased to serve as your Deputy Chair for the WHO committee of JEJUMUN XII. This marks my second year on the MUN, as a rising 8th grader. Debating on the agenda of formulating an international standard on the safe usage of gene editing and CRISPR technology in the global community, I am excited to witness the engaged debate between delegates who truly wish to resolve the urgent agenda in the medical field. Like your passion for the conference, I strongly desire to lead delegates to have a successful conference, not just in academic ability, but also to build a meaningful memory and relationship with other participants. See you at the conference!

Welcome to the WHO committee in JejuMUN 2025! I'm Joey Yu, and I will be serving as your associate chair. It is my great pleasure to welcome you to this upcoming conference, where numerous memorable discussions will take place. I'm currently a sophomore at Korea International School Jeju, and it's been almost 2 years since I started my MUN journey. This will be my first time serving as an associate chair for the offline Model United Nations (MUN) in South Korea. One must keep in mind that all delegates should have real fun and debate meaningfully! I'm fully confident that your experience in JejuMUN will be genuinely helpful and valuable for your future, to remain as a great memory later. I hope all the delegates will leave with an unforgettable experience at Jeju MUN XII. See you there.

Sincerely,

Jueon Kang | jekang29@kis.ac

Yejun (Chris) Choi | yjchoi30@kis.ac

Chaeyeon (Joey) Yu | cnyu28@kis.ac

Historical Background

Pre-1960s

The official creation and the development of DNA in the early 1960s led the global community into the biology revolution. The significant discoveries of biology and genetics provided a path for future study of the gene-related field.

1960-1970s

The ideology of gene-editing, DNA linking, and engineering began to flourish, mostly originating from Silicon Valley. Numerous discoveries and events have contributed to the development.

1960s: Discovery of the genetic code:
The genetic code, which distinguishes how DNA and RNA sequences determine the amino acid sequences in proteins, was discovered by Francis Crick. The discovery described the sequence of DNA which are essential for all cellular functions.

1968: Discovery of Restricted Enzymes
Werner Arber, a microbiologist from Switzerland, had discovered the Restriction Enzymes, based on the hypothesis that bacteria produce two kinds of enzymes to prevent infection: restriction and modification enzymes. This discovery enabled gene editing and paved the way for CRISPR.

2000-2011

As the new millennium began, the prior function of CRISPR technology began to advance. The principle of CRISPR technology was first pioneered by Francisco Mojica, a Spanish microbiologist, in the 1990s. He had characterized a constant repeating DNA sequence, which led to the discovery that provided the idea for generating CRISPR technology.

2012-2018

In 2012, CRISPR-Cas9 was first recognized from the discovery of the CRISPR Genome Engineering tool by Jennifer Doudna, Emmanuelle Charpentier, and their teams. Through a targeted cut in the DNA, it had opened a new generation in overcoming the genetic issues. A guide RNA molecule is utilized in order to direct the Cas9 protein to move it to a specific location in the genome, and it cuts the DNA. The discovery immediately led to public excitement over the appearance of the new technology.
However, the CRISPR technology soon rose to the table in the debate over the ethics and safety implications. While the germline editing skill ensures the safety of reproductive DNA, it raises a significant ethical question. The community faced issues with the safety implications of the CRISPR technology, with concerns about off-target damages and potential unintended effects on future generations. In response, the National Academy of Sciences, the National Academy of Medicine, the Chinese Academy of Sciences, and the Royal Society of the UK organized an International Summit in Washington, D.C. in December 2015 to discuss scientific development on the path of gene-editing and to reduce the stress of ethical and safety concerns within the field.

2020-2022	The World Health Organization (WHO) and the international organization have developed a policy and international standard on genetic editing. In 2018, the WHO established an Expert Advisory Committee on Developing Global Standards for Governance and Oversight of Human Genome Editing to respond to the first gene-edited baby born and reduce the stress of ethical issues and safe implications of CRISPR and germline editing. The committee takes responsibility for examining numerous challenges associated with the agenda and creating appropriate governance mechanisms from local to global scales. It started to regulate the technology in the belief of ethics, but it required more action.
Status quo	While the policy and specific regulations had been adopted, still more development. As gene-editing technology has expanded in the global health care field, a global consensus is strictly required to utilize an innovative technology safely, with moral decisions.

Key Terms

Gene editing (Genome editing)
A Biotechnology that precisely modifies a living organism's DNA by inserting, cutting, or deleting a DNA sequence. Gene editing includes targeting changes to an organism's DNA, utilizing molecular tools such as CRISPR-Cas9, acting as scissors to cut DNA at a specific location.

CRISPR-CAS9
Refers to *Clustered Regularly InterSpaced Palindromic Repeats/Cas9*, a gene editing technology that precisely alters the DNA sequence. The technology includes guiding RNA molecules to target specific DNA sequences, a protein acting as a specific molecular scissors, cutting the DNA, and repairing the divided DNA.

Genetic disease
A condition caused by an abnormality or mutation in a living organism's genes (DNA) or chromosomes. It can affect numerous aspects of health, including chronic discomfort and severe disability.

Biomedical science
A field of science that applies biological technology to physical and medical science for healthcare and biologic-health, aiming to conduct laboratory and scientific research to treat and diagnose disease.

Off-Target Effects
Unintended actions of the gene editing tool on DNA molecules, resulting in effects apart from intended targets.

Ethical regulation
Controlling actions and decisions based on morality and ethics through guidelines and rules.

Germline Guiding
The leading process to the clinic and treatment decision is based on germline genetic testing, which identifies the DNA from the reproductive cells.

Gene therapy
The medical approach to treat and further prevent genetic disease or illness.

Global Health Equity
Ensuring the health of everyone, regardless of their origin, background, or specialty, has the right to get a fair and equal opportunity to maintain their health condition.

Current State of Affairs

Gene editing and CRISPR technologies have paramount importance in advancing healthcare worldwide. That said, its standards for the safe and equitable usage are often neglected. While Casgevy, the first approved CRISPR therapy that treats sickle cell, was accessible across the US, UK, and EU between 2023 and 2024. The most affected regions by sickle cell, like India, were confined to Casgevy. Many policies and options to address ethical concerns worldwide have been attempted, for example, a 10-year moratorium on CRISPR usage in some scientific organizations, but the technology still lacks medical justification for its usage.

In 2018, a Chinese scientist, He Jiankui, actualized the affair around gene technologies by claiming his first genetically edited babies. Modifying embryos using CRISPR to implant, he gave birth to two girls, raising disputes over moral concerns in China. Even though nations tightened their regulations after his scandal, there remain fears that the pressured biotechnology industry might be encouraged to have similar risky experiments shortly.

Currently, despite many conferences being in place, there is no single unified international corporate treaty for CRISPR and gene editing; instead, they only regulate these technologies on an inconsistent basis. China, the US, and the EU have their own distinct rules and frameworks, meaning companies are able to look for the countries with the weakest regulations and move their research there: forum shopping. Furthermore, the CRISPR therapies, on average, cost upwards of $2 million per patient, and consequently, only wealthy countries can access them. There is no coordinated system to support equitable distribution worldwide, raising concerns for patient rights. Populations in low- and middle-income regions are the ones that bear the majority of the high burden of genetic diseases, and they are also the ones who are effectively left behind.

Despite being considered far more precise than old gene editing technologies, new research shows that CRISPR can still cause unintended edits in the genome, which can trigger cancer or other hazardous side effects. International standards are needed for setting minimum safety testing protocols, reporting requirements, and acceptable risk criteria so that they are properly managed before treatments reach patients. Global standards are imperative for outlining pre-screening methods for immune compatibility, since unexpected immune responses are putting patient safety at risk. As mentioned, the high costs of current therapies make them hardly available to low-income countries. To let vulnerable populations not be left out in the treatment process, international frameworks are urged to address price transparency, the share of technology, and capacity building.

Therapies are being approved, and delivery methods are being improved and advanced. Still, this raises complex new threats like ethical erosion and misuse of tools. The committee must aim to coordinate efforts internationally for creating regulations and standards that can preserve the rights of low-income countries in getting treatment equally with respect.

Stances of Parties

Australia
Australia strongly buttresses scientific innovation that may occur regarding gene editing, but it explicitly bans acts that can furtively violate ethical concerns with the Prohibition of Human Cloning for Reproduction Act (2002). Aligning with all other countries, Australia necessitates licensing for any embryo use in research, favoring clearer laws for halting legal ambiguities around evolving CRISPR and gene editing capabilities.

Brazil
Brazil is actively involved in gene editing research and is utilizing the technology in the public healthcare system. Brazil is focused on research on in vitro or ex vivo gene editing in somatic cells, with the limitation of human reproductive organs. Brazil's public healthcare system provides a comprehensive gene therapy system, particularly for rare genetic diseases. With the regulatory framework from Anvisa, Brazil develops the technology.

Canada
Canada has a strict stance on gene editing and CRISPR technology, in particular, standing on the side of morality and ethical responsibility. Granted, they are still supportive of gene editing, somatic, for medical purposes, but still wary of heritable modifications. They passed their primary legislation in 2004 called the Assisted Human Reproduction Act, which defined genome editing as punishable and could grant up to 10 years of imprisonment.

Chile
Chile follows a prohibition on human germline editing similar to that of European nations. This prohibits any reproductive usage and research on the CRISPR-Cas9. Research usage in Chile is based on a case-by-case basis, but Chile is still in need of clear frameworks and guidelines for the gene editing technology.

Colombia
Colombia's current governance approach for gene editing technology is also geared toward agriculture without explicit policies on human CRISPR research. While the country prohibits germline editing for reproductive usage, in vitro research is allowed under certain conditions, which clearly highlights a gap in clinical policy. For example, Colombia is actively involved in research focused on hereditary cancers and infectious diseases.

People's Republic of China
After the controversial case involving the birth of gene-edited babies, China approaches the technology with both constant advancements and firm regulation. In 2018, the Chinese scientist He Jiankui announced that he had used CRISPR technology to gene-edit human embryos to confer resistance to HIV, without any permission from the government. Recognizing the controversial case, China is leading the CRISPR-Cas9 technology with strict regulation, including the use of the technology on crops. The government places a high amount of financial support in conducting CRISPR technology research.

France
France's research and health-provision system on gene-editing technology is focused on the safe application of CRISPR-Cas9 in healthcare, ensuring the ethical use in the nation. Like other European nations, France prohibits heritable modification on the human genome, but some exceptions, such as therapy, are created. Since the nation is also grappling with ethical issues on GMOs, strict regulations are controlling the development of the field. France stands as one of the influential nations in the European biotechnology industry.

Germany
As a European Nation leading in gene editing, Germany maintains a cautious stance on the technology, specifically regarding human reproductive modification. Under the specific circumstances, modifying genes in body cells is prohibited, but other research for ethical purposes is allowed in Germany, including Somatic Gene editing. With the strict legal framework, Germany is nationally addressing and discussing the ethics of gene editing. Hence, with a strong framework, it is expected that Germany will lead the establishment of an official global framework on Gene editing and the CRISPR technology.

India
India is taking significant action in genetics, in the research and its application in healthcare, but also in agriculture. India had first launched gene therapy in history, called CAR-T technology, in April 2024. Making an effort by creating a price affordable to provide accessible treatment to every citizen, India differentiates itself from other nations in the gene-editing technology. As India is leading the GMO genetically edited agriculture technology, it is expected to enhance the gene-editing technology and further create notable achievements in history.

Israel
Israel prohibits germline gene editing for reproductive purposes under the Prohibition of Genetic Intervention Law. However, exceptions exist for the current research purposes with approval from the Minister of Health. This regulatory stance is currently known for its ethical oversight while also allowing adequate research in the field.

Japan
Japan is leading the Genetic editing in Asia, while the government is strictly restricting the research and utilization of gene-editing technology for reproductive purposes. Currently, Japan is using the technology in a "treatment" usage, but with restrictions on reproductive uses. The Ministry of Education, Culture, Sports, Science, and Technology allows research, but holds a responsibility in regulating its usage for other unethical purposes.

Malaysia
Similar to nations like Thailand, Malaysia has concerns about creating a regulatory framework for gene editing technologies. Modern biotechnology has raised several questions about the regulation of gene editing technology. Even though standards on the cell-based clinics and stem cells exist, there are no frameworks for gene editing yet. Multiple regulatory frameworks may be beneficial for Malaysia.

Mexico
In Mexico, there is an existing regulatory framework for human genome editing governance. However, there are public opinions for the reformation of such a guideline to remove possibilities of unethical usages. As it bans genome editing research but does not ban the implementation of edited embryos, it shows inconsistency in the domestic policy. Reformation seems necessary for Mexico's guidelines.

New Zealand
New Zealand is actively preparing to expand gene editing regulation beyond agriculture through the legislation planned for the end of 2025. This means the support of commercialization of low-risk gene editing technologies, which would allow the human therapeutic application. This shows a step towards oversight in line with global standards.

Nigeria
Nigeria has established the National Biosafety Management Agency to regulate modern biotechnology, but it currently lacks specific regulations and development towards human genome editing. The public opinion of Nigeria is geared towards the support of such a technology to cure inherited diseases, despite concerns about morality. The absence of clear legal frameworks raises ethical and safety concerns regarding human genome editing practices.

Norway
As a medical-leading nation across the globe, Norway is currently permitting in vitro germline CRISPR research. However, Norway strictly prohibits reproductive gene editing in the current status quo. The Biotechnology Board approved the basic research in 2016 under the limitation of embryos up to 14 days, but clinical and heritable usage of such a technology remains prohibited in Norway.

Kenya
Kenya has developed a regulatory framework for genome editing; however, they are not focused on human genome editing. The country's biosafety regulations geared towards agriculture may be applied to future human genome editing technology. However, Kenya requires a safe and government-approved framework for the equitable usage of genome editing.

Republic of Korea
As well as Japan, Korea is one of the leading countries in gene-editing health care, but it regulates the technology for bioethics and biosafety. Bioethics and safety law policy in Korea establishes a framework for ethical research in genome editing, without interfering with the nature of reproduction. South Korea had also established the National Bioethics Committee to advise on the national research agenda and preserve biosafety. On behalf of regulations, South Korea actively advances gene editing technology as a medical act, with the nation's developed scientific advancement.

Singapore
Similar to the United Kingdom, Singapore considers somatic gene editing for therapeutic purposes as an acceptable treatment. Still, they harshly ban clinical heritable editing to prevent potential consequences that raise ethical concerns. They regulated gene-editing research via the Human Biomedical Research Act (HBRA) in 2014 and the Healthcare Services Act in 2020. They frequently participate in international bioethics forums to match global standards for gene editing.

South Africa
South Africa recently amended its Health Research Ethics Guidelines in May 2024 to include heritable human genome editing as part of the nation's research, under strict regulations involving long-term monitoring. However, South Africa's National Health Act still bans the manipulation of genetic material for reproductive purposes, which creates legal ambiguity.

Spain
Spain is actively involved in gene editing research and its application in nationwide health care, to explore the potential of CRISPR technology and to revolutionize the genetic field. Spanish scientists are highly engaged in treating genetic diseases and increasing the precision and accuracy of the CRISPR tool. While, as a member of the European Union, Spain had fundamentally set a framework through EU regulation for genetic editing.

Switzerland
Switzerland is actively involved in gene editing research and therapy development, with both focusing on therapy and agricultural purposes. While the government has strict regulations on germline editing, emerging somatic gene editing has enabled Swiss scientists to develop the technology and apply it to the treatment. As Switzerland is currently considering relaxing the restriction on gene-edited crops, it is expected to influence the gene editing technology on human health.

Thailand
Thailand's current regulatory framework and the huge development of gene editing technology are not taking place in the status quo. However, research is underway to explore the potential of gene editing technology to treat genetic diseases. However, similar to Kenya, the interest in gene editing technology based on public opinion is at a high level. Furthermore, Thailand has also established guidelines for gene editing in agriculture, indicating a cautious approach similar to Kenya.

United Kingdom
The UK is wary of the significant danger of gene editing, yet they are supportive, especially for therapeutic and research purposes. Action granted in 1990, the key law aligning with this is the Human Fertilisation and Embryology Act, which confines germline editing to the intention of sole research, strictly prohibiting clinical reproduction. The UK is currently advocating for global standards to be firmly implemented so that proper regulation is stabilized.

United States of America

The United States stands as a major stakeholder in Genome editing and CRISPR technology, with its active involvement in Gene Therapy research and the advancements in CRISPR technology. In 2017, the U.S. Food and Drug Administration (FDA) approved the utilization of gene editing under certain conditions, including cancer and genetic disorders treatment. With the government's active support (National Institute of Health), the United States is currently providing Clinical healthcare and advancing the CRISPR technology for more precise and successful treatment. Hence, the United States is leading the global Gene editing field.

Possible Solutions

Creation of a global regulatory framework ensuring the ethical usage of gene editing technology
As the ethical controversy arises from the gene-editing technology, countries can develop an international framework under the United Nations that regulates the usage of CRISPR-CAS9 technology, which ensures ethical usage of such technology. Being a regulatory framework, it is important for such a regulation to be flexible for national adaptation, but it should include methods to ensure the transparency of such a treaty.

Creation of a funding system to increase the accessibility of a technology
As mentioned above, the current gene editing technology has not been developed in developing nations and is inaccessible to those with low incomes or difficult situations. However, increasing the accessibility of such a technology to the vulnerable stakeholders of diseases seems very important. Considering those factors, nations may develop a Public-Private-Partnership (PPP) or propose a global fund to support developing countries' access to gene editing research, clinics, and treatments.

Development of the mechanism of ensuring the equitable distribution of gene editing and CRISPR technologies across all regions of the world
Recognizing the differentiating development of advanced gene-editing technologies between high-income and low-income nations, it is pivotal to bridge the technological gap between income-contrasting countries in order to successfully formulate an unbiased international standard. Through providing financial support through funding mechanisms and creating a portion of technology with constant interaction, the technologies will be able to reach vulnerable populations in lagging countries.

Bolstering the Expert Advisory Committee on Developing Global Standards for Governance and Oversight of Human Genome Editing
While the Expert Advisory Committee is established to reduce the stress of ethical issues and the safe implications of CRISPR and germline editing, it lacks a binding device since it only recommends to the community regarding the ethical use of gene editing technologies. Bolstering the committee will promote transparency and pacify the ethical controversy of gene editing usage.

Questions to Consider

1. What financial or structural frameworks can be implemented to promote equitable access to the CRISPR-CAS9 technology?

2. How can international organizations and medical sectors cooperate for the development of CRISPR-CAS9 technology?

3. To what extent should ethical concerns be applied in the regulation of gene editing technology?

4. How can nations with a basic level of biomedical technology transform their current knowledge into a successful implementation of human genome editing?

5. What are the incentives for the developed nations to share and participate in increasing access to human gene editing technology?

6. Can nations create a “universally acceptable” ethical standard for gene editing technologies, so that it remains regionally defined?

7. Are there any educational programs that can enlarge biomedical institutions to encourage responsible use of CRISPR for future generations?

8. What incentives might be developed for nations to receive in response to democratizing access to gene editing technologies?

9. How can low-income countries be granted the equal use of CRISPR or gene editing technologies?

Bibliography

Adem, Dr. “Germany Prepares New National Strategy for Gene and Cell Therapies.” *Inside EU Life Sciences*, 18 June 2024, www.insideeulifesciences.com/2024/06/18/germany-prepares-new-national-strategy-for-gene-and-cell-therapies/. Accessed 25 July 2025.

Baylis, Françoise. “South Africa Amended Its Research Guidelines to Allow for Heritable Human Genome Editing.” *The Conversation*, 24 Oct. 2024, theconversation.com/south-africa-amended-its-research-guidelines-to-allow-for-heritable-human-genome-editing-241136. Accessed 25 July 2025.

Berlincourt, Jade, et al. “Experts’ Perspectives on Human Gene Editing in Switzerland.” *Journal of Community Genetics*, Springer Science+Business Media, Dec. 2024, https://doi.org/10.1007/s12687-024-00757-0. Accessed 25 July 2025.

Cohen, Jon. “It’s a CRISPR Revolution: China Becomes a World Leader in Genome Editing.” *Science*, 2019, www.science.org/content/article/its-crispr-revolution-china-becomes-world-leader-genome-editing. Accessed 25 July 2025.

Council of Europe. “Genome Editing Technologies: Final Conclusions of the Re-Examination of Article 13 of the Oviedo Convention.” *Human Rights and Biomedicine*, 10 Oct. 2022, www.coe.int/en/web/human-rights-and-biomedicine/-/genome-editing-technologies-final-conclusions-of-the-re-examination-of-article-13-of-the-oviedo-convention. Accessed 25 July 2025.

Cyranoski, David. “CRISPR Gene-Editing Tested in a Person for the First Time in the United States.” *Nature*, 9 Nov. 2019, www.nature.com/articles/d41586-019-03617-x. Accessed 25 July 2025.

Gostimskaya, I. “CRISPR-Cas9: A History of Its Discovery and Ethical Considerations of Its Use in Genome Editing.” *Biochemistry (Moscow)*, vol. 87, no. 8, Aug. 2022, pp. 777–788, https://doi.org/10.1134/S0006297922080090. PMID: 36171658; PMCID: PMC9377665.

Government of India. “India Strengthens Genome-Editing Regulation.” *Press Information Bureau*, 13 July 2023, www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2017142. Accessed 25 July 2025.

Heuer, Hanna, et al. “Genetic Counseling in Germany: A Nationwide Program to Improve Access and Quality.” *European Journal of Human Genetics*, 2025, www.nature.com/articles/s41431-025-01807-y. Accessed 25 July 2025.

“India: Germline / Embryonic.” *Global Gene Editing Regulation Tracker*, 16 Dec. 2019, crispr-gene-editing-regs-tracker.geneticliteracyproject.org/india-germline-embryonic/. Accessed 25 July 2025.

Kalidasan, V., and Theva Das K. “Is Malaysia Ready for Human Gene Editing: A Regulatory, Biosafety and Biosecurity Perspective.” *Frontiers in Bioengineering and Biotechnology*, vol. 9, 11 Mar. 2021, https://doi.org/10.3389/fbioe.2021.649203. PMID: 33777918; PMCID: PMC7992004.

Knoppers, Bartha M., et al. “Genetic Counseling and Testing.” *Global Health and the Future Role of the United States*, National Academies Press (US), 2017, www.ncbi.nlm.nih.gov/books/NBK447261. Accessed 25 July 2025.

Ledford, Heidi. “CRISPR Babies: When Will the World Be Ready?” *Nature*, vol. 564, 2018, pp. 20–22, www.nature.com/articles/d41586-018-06847-7. Accessed 25 July 2025.

Mackenzie, Robin, and Yann Joly. “Global Regulatory Trends in Genome Editing.” *Trends in Biotechnology*, vol. 41, no. 12, 2023, pp. 1200–1208, www.sciencedirect.com/science/article/abs/pii/S0167779923003359. Accessed 25 July 2025.

Mayo Clinic Staff. “Gene Therapy.” *Mayo Clinic*, 8 Mar. 2024, www.mayoclinic.org/tests-procedures/gene-therapy/about/pac-20384619. Accessed 25 July 2025.

MedlinePlus Genetics. “What Are Genome Editing and CRISPR-Cas9?” *MedlinePlus*, 2023, medlineplus.gov/genetics/understanding/genomicresearch/genomeediting/. Accessed 25 July 2025.

National Institutes of Health. “Gene Editing.” *NIH*, www.nih.gov/news-events/digital-media-kits/gene-editing. Accessed 25 July 2025.

“Norwegian Biotechnology Advisory Board Recommends Allowing Human Germ Line Editing for Basic Research.” *Bioteknologirådet*, 12 Jan. 2016, www.bioteknologiradet.no/2016/01/the-norwegian-biotechnology-advisory-board-recommends-allowing-human-germ-line-editing-for-basic-research/. Accessed 25 July 2025.

“Reading the Genetic Code.” *Nature Education*, www.nature.com/scitable/topicpage/reading-the-genetic-code-1042/. Accessed 25 July 2025.

Research and Markets. “CRISPR-Based Gene Editing Market Report 2025, with Company Profiles of the Top 10+ Major Market Players.” *GlobeNewswire*, 13 Jan. 2025, www.globenewswire.com/news-release/2025/01/13/3008737/28124/en/CRISPR-based-Gene-Editing-Market-Report-2025-with-Company-Profiles-of-the-Top-10-Major-Market-Players.html. Accessed 25 July 2025.

Reuters Staff. “New Zealand to Loosen Gene Technology Regulation to Make Commercialization Easier.” *Reuters*, 12 Aug. 2024, www.reuters.com/science/new-zealand-loosen-gene-technology-regulation-make-commercialization-easier-2024-08-12. Accessed 25 July 2025.

Risa, Mette. “The Norwegian Biotechnology Advisory Board Recommends Allowing Human Germ Line Editing for Basic Research.” *Bioteknologirådet*, 12 Jan. 2016, www.bioteknologiradet.no/2016/01/the-norwegian-biotechnology-advisory-board-recommends-allowing-human-germ-line-editing-for-basic-research/. Accessed 25 July 2025.

Roberts, Michelle. “China Baby Gene Editing Claim ‘Dubious.’” *BBC News*, 26 Nov. 2018, www.bbc.com/news/health-46342195. Accessed 25 July 2025.

Schreiber, Kayleen. “Israel: Germline / Embryonic.” *Global Gene Editing Regulation Tracker*, Oct. 2019, crispr-gene-editing-regs-tracker.geneticliteracyproject.org/israel-germline-embryonic/. Accessed 25 July 2025.

Stein, Rob. “Child Undergoes CRISPR Gene Editing for Genetic Disease.” *NPR*, 15 May 2025, www.npr.org/sections/shots-health-news/2025/05/15/nx-s1-5389620/gene-editing-treatment-crispr-inherited. Accessed 25 July 2025.

Subica, Andrew M. “CRISPR in Public Health: The Health Equity Implications and Role of Community in Gene-Editing Research and Applications.” *American Journal of Public Health*, vol. 113, no. 8, Aug. 2023, pp. 874–882, https://doi.org/10.2105/ajph.2023.307315. Accessed 25 July 2025.

Synthego. “Genome Engineering: A History.” *Synthego*, www.synthego.com/learn/genome-engineering-history. Accessed 25 July 2025.

Tamura, K. “The Genetic Code: Francis Crick’s Legacy and Beyond.” *Life*, vol. 6, no. 3, 25 Aug. 2016, p. 36, https://doi.org/10.3390/life6030036. PMID: 27571106; PMCID: PMC5041012.

“Statutes of the Republic of Korea.” *KLRI*, 2019, elaw.klri.re.kr/eng_mobile/viewer.do?hseq=33442&type=part&key=36#:~:text=The%20purpose%20of%20this%20Act%20is%20to,materials%20or%20of%20handling%20embryos%2C%20genes%2C%20etc. Accessed 25 July 2025.

Tilleke & Gibbins. “Genome Editing in Thai and Indonesian Agricultural Biotechnology.” *Tilleke & Gibbins*, www.tilleke.com/insights/genome-editing-in-thai-and-indonesian-agricultural-biotechnology. Accessed 25 July 2025.

World Health Organization. “WHO Issues New Recommendations on Human Genome Editing for the Advancement of Public Health.” *WHO*, 12 July 2021, www.who.int/news/item/12-07-2021-who-issues-new-recommendations-on-human-genome-editing-for-the-advancement-of-public-health. Accessed 25 July 2025.