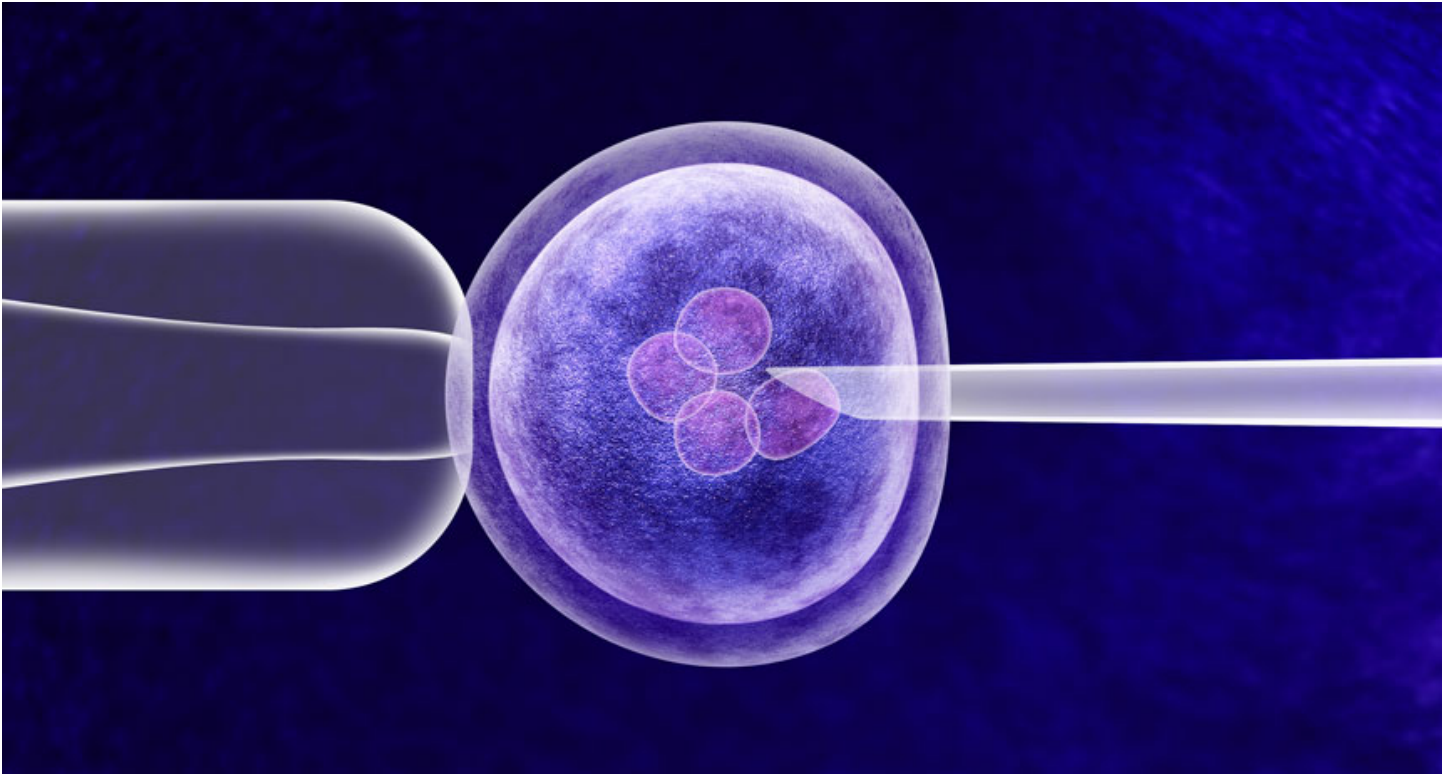


ScienceNews

EDUCATOR GUIDE



LIGHTSPRING/SHUTTERSTOCK

April 13, 2019

Ban on Gene-edited Babies Proposed



SOCIETY FOR SCIENCE & THE PUBLIC

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Ban on Gene-edited Babies Proposed

About this Guide

In “[Ban on gene-edited babies proposed](#),” *Science News* reports that 18 researchers, including pioneers of a popular gene-editing tool, are calling for a global moratorium on any gene editing that changes heritable DNA to make genetically modified children. The call comes after a Chinese researcher announced that he had edited DNA in embryos that resulted in the birth of two baby girls last year. This Guide explores basic topics related to gene editing and other applications of genetic engineering. The debate activity asks students to argue an assigned viewpoint on the creation of gene-edited babies but can be easily adapted for other science-related debate topics.

This Guide includes:

Article-based observation, Q&A — Students will answer questions based on the *Science News* article “[Ban on gene-edited babies proposed](#),” Readability: 12.7. Questions ask students to recall and explain what the researchers are proposing and why, to define terms from context and to consider questions that the article doesn’t address. Another version of the article, “[Some scientists ask for ban on the gene editing of babies](#),” Readability: 8.8, appears on *Science News for Students*.

Article-based observations, questions only — These questions are formatted so it’s easy to print them out as a worksheet.

Cross-curricular connections, teacher guide — The discussion prompts provided encourage teachers to revisit basic topics including DNA, genetic variability and modification, and heritability. After reviewing concepts, teachers can lead a class discussion (or send students off on their own) exploring how genetic engineering has been used to fight or treat disease, to support or improve agriculture, and for basic research.

Activity: The Great Gene-editing Debate

Purpose: Using the suggested debate protocol, students will research and debate a contentious issue, arguing an assigned viewpoint based on scientific evidence. This debate is focused on gene editing for the creation of human babies, but can be easily adapted for other topics.

Approximate class time: 2 class periods.

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Standards

Next Generation Science	Common Core ELA
From Molecules to Organisms: Structures and Processes: HS-LS1-1	Reading Informational Text (RI): 1, 2, 4, 5, 7
Heredity: Inheritance and Variation of Traits: HS-LS3-1, HS-LS3-2	Writing (W): 1, 2, 3, 4, 6, 7, 8, 9
Biological Evolution: Unity and Diversity: HS-LS4-1	Speaking and Listening (SL): 1, 2, 4, 5, 6
Engineering Design: HS-ETS1-1, HS-ETS1-2, HS-ETS1-3	Reading for Literacy in Science and Technical Subjects (RST): 1, 2, 3, 4, 5, 7, 8, 9
	Writing Literacy in History/Social Studies and Science and Technical Subjects (WHST): 1, 2, 4, 7, 8, 9

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Article-Based Observation, Q&A

Directions: After students read the article "[Ban on gene-edited babies proposed](#)," have them answer the questions below.

1. What is a moratorium? What are the specifics of the one described in the article?

A moratorium is a temporary ban on the use or application of something. In the proposed moratorium, scientists wouldn't be allowed to edit the genes of eggs, sperm or embryos to make genetically modified children for about five years.

2. What, according to the article, would still be allowed under the proposed moratorium?

Scientists could still use this type of gene editing for research and could still treat diseases by editing genes that don't get passed on to future generations.

3. From the context provided, what is CRISPR?

A type of gene-editing tool that is still being tested and refined.

4. Who is calling for the ban and why is their support important?

Eighteen scientists, including Feng Zhang and Emmanuelle Charpentier, are calling for the ban. The support of Zhang and Charpentier is important because they helped pioneer CRISPR technology and are involved in the gene-editing field.

5. Give two reasons why researchers think the ban of about five years is needed?

The ban will give scientists time to further test gene-editing tools and to make them safer. It also will allow time for public education and debate about gene-editing experiments. Students might also say that the ban is needed because previous statements on gene-edited babies have not been effective.

6. Identify and define at least two terms in the article that aren't familiar to you. How does knowing these words help you understand the article?

Germ line refers to the cells, including egg and sperm cells, that organisms use to pass along their genes to the next generation. The scientists calling for the ban are specifying that gene-editing can't be used on these cells because such changes would be heritable.

Clinical refers to work that is done in a medical clinic and involves a living patient. Scientists are arguing that gene editing of heritable traits shouldn't be done in people until the technology is more mature.

7. How does this call for a ban compare with previous statements from scientists on gene editing?

This proposal is very similar to previous statements but uses the stronger language of the word “moratorium,” or ban.

8. If the ban doesn’t have legal weight, why might scientists follow it?

Scientists may be reluctant to do something that their peers, or government, have agreed is wrong. A scientist who wants to go against the ban might face criticism or have difficulty getting support from colleagues.

9. What did Chinese scientist Jiankui He do last year? How does bioengineer Russ Altman think He’s actions will affect this ban?

Jiankui He edited embryos that resulted in the birth of two babies. Altman thinks the breach might make people pay more attention and be more likely to follow the moratorium.

10. What questions do you have after reading this article?

How many and which countries have adopted this ban? Did scientist Jiankui He face any consequences because of his work? Are the gene-edited babies that were born last year healthy? What future benchmarks in CRISPR research will indicate when the technology is safe enough to create gene-edited babies?

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Article-Based Observation, Q

Directions: Read the article "[Ban on gene-edited babies proposed](#)" and answer the questions below.

1. What is a moratorium? What are the specifics of the one described in the article?
2. What, according to the article, would still be allowed under the proposed moratorium?
3. From the context provided, what is CRISPR?
4. Who is calling for the ban and why is their support important?
5. Give two reasons why researchers think the ban of about five years is needed?
6. Identify and define at least two terms in the article that aren't familiar to you. How does knowing these words help you understand the article?
7. How does this call for a ban compare with previous statements from scientists on gene editing?
8. If the ban doesn't have legal weight, why might scientists follow it?
9. What did Chinese scientist Jiankui He do last year? How does bioengineer Russ Altman think He's actions will affect this ban?
10. What questions do you have after reading this article?

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Cross-Curricular Connections, teacher guide

Directions for teachers: After students have had a chance to read "[Ban on gene-edited babies proposed](#)," review what students know about some related science concepts including DNA, variability and heritability. You can lead a class discussion using the questions provided. After reviewing basic concepts, have students draw on their past knowledge or search the *Science News* archive and other resources to come up with examples of how genetic engineering has been used in the past.

Review topics

DNA: Ask students to recall the structure of DNA and define what genes are. They can also discuss how DNA structure determines the structure and function of proteins.

Genetic variability and modification: Ask students to define genetic variability and discuss how changes in DNA are introduced through normal mating processes as well as mutations caused by other factors. Ask students to recall the history of humans' role in genetic modification, from selective breeding to genetic engineering.

Heritability: Ask students to discuss what makes some changes in DNA heritable, with a focus on germ line (or sex) cells. Review how these DNA changes get passed down through generations, and how the changes can affect people's lives.

Genetic engineering applications

1. Name one example of how genetic engineering has been used to fight or treat disease. What is the disease? What information can you find about what DNA has been modified and how? What is the effect of that modification? Is it a heritable change?

Students might mention that scientists are experimenting with genetic engineering in the lab to [control malaria-carrying mosquitoes](#). Researchers use the gene-editing tool CRISPR/Cas9 to engineer [bits of DNA into a gene drive](#). A gene drive inserts itself into an organism and spreads quickly through a population, forever altering offspring or preventing offspring from being born.

Students may also say something about using genetic engineering to modify immune cells to [treat diseases like leukemia](#) and [lung cancer](#). Or they might mention how scientists use genetic engineering to figure out how to make medicines more efficiently. Recombinant DNA technology, for example, was used to [insert insulin-making genes into bacteria](#). The modified bacteria could then churn out large quantities of the drug.

2. Name one example of how genetic engineering has been used to support or improve agriculture. What organism was modified? What information can you find about what DNA has been modified and how? What is the effect of that modification? Is it a heritable change?

Students could mention using [genetic engineering to make certain crops resistant](#) to things like droughts, floods, pests or extreme temperatures. Genetic engineering could also be used to [increase crop yields](#).

Students may also discuss how genetic engineering is used on animals that people eat. One example is salmon that were given a gene from another fish to make the salmon grow bigger faster. Those salmon were [the first genetically engineered animals cleared for human consumption](#) anywhere in the world.

3. Name one example of how genetic engineering has been used for basic research. What organism was modified? What can you find about what DNA has been modified and how? What is the effect of that modification? Is it a heritable change?

Students might say that genetic engineering is used to manipulate lab animals. For instance, researchers have engineered [breeds of mice that mimic symptoms of human diseases like Alzheimer's](#). Scientists experiment with these animals in an attempt to unravel the causes and test potential treatments for the disease. Other researchers are [engineering more exotic critters, like cephalopods, to turn them into lab animals](#). Cephalopods could be used to study motion, camouflage and neural systems. Such research could have applications for robotics, computing, prosthetics and more.

Students could discuss how genetic engineering can be used to explore which genes are essential for life. For instance, researchers created a bacterium that has [the smallest genome needed for free living](#), with just 473 genes. Students might also talk about how researchers are using [gene editing to store data within DNA](#). Scientists have encoded audio recordings, short movies, poetry and even entire books into bacterial DNA.

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Activity Guide for Teachers: The Great Gene-editing Debate

Purpose: Using the suggested debate protocol, students will research and debate a contentious issue, arguing an assigned viewpoint based on scientific evidence.

Procedural overview: After being introduced to a contentious issue with multiple viewpoints, three groups of students will be assigned different stances and will research and argue their stances based on scientific evidence. A fourth group of students will research scientific background knowledge on the topic, so they can moderate the debate fairly and ultimately choose a winning team. This activity provides an example protocol for a debate focused on the creation of gene-edited babies, as discussed in the *Science News* article "[Ban on gene-edited babies proposed.](#)" The activity can be adapted for any contentious issue that can be argued from credible resources and scientific evidence.

Approximate class time: 2 class periods (1 for preparation and 1 for the debate).

Supplies:

Debate Preparation Sheet (for students)
Clock

Directions for teachers:

Choose a topic with multiple viewpoints that can be argued using scientific evidence and determine a pro statement, con statement and intermediate viewpoint. Come up with a few background questions that will explore core scientific concepts and give meaning and purpose to the debate (Background Questions) and two additional questions that students should address during the debate (Debate Questions). The additional questions should encourage students to think about how their viewpoint might be applied outside of the classroom. Questions might, for example, ask how larger organizations such as the government or the general scientific community should proceed.

Divide your class into four teams, with approximately 5–7 students on each team: Team 1 (pro), Team 2 (intermediate), Team 3 (con) and Team 4 (moderators/judges).

In class on the first day, hand out the debate preparation sheet. Using the questions on the sheet as a guide, Teams 1–3 will need to research and prepare a general opening argument and answers to the Debate Questions. They'll also want to do enough background research for possible rebuttals and a closing argument. Tell students to make sure all team members speak before a team member speaks a second time.

Team 4 will be responsible for monitoring, moderating and judging the debate. Students on Team 4 should be assigned to fill the following roles: research and present answers to Background Questions, moderate the debate by asking questions, keep track of speaking time per team, take notes throughout the debate, and present the debate results and reasoning. Once the debate closes, help students on Team

4 answer the relevant questions on the debate preparation sheet, so they can choose and announce the winning team.

Students should be prepared to speak confidently about their viewpoints and may want to prepare notecards that capture speaking points. Any preparation not completed during class should be completed for homework.

For debate day, arrange the classroom so that it is conducive to the four-team format. Align chairs in a large square along the perimeter of the room, assigning a team per side and having the speaker stand in the middle. Alternatively, place four “speaking chairs” facing each other toward the middle of the room, and place chairs for additional team members positioned behind each “speaking chair.”

Allow students to run the debate based on the debate protocol provided below. The debate protocol is designed to fit into an hour-long class period, with each team getting 14 minutes of speaking time. You can adjust the debate schedule and timing as necessary.

As the teacher, be sure to step in if arguments veer away from scientific evidence. After all groups have presented their closing arguments, convene with Team 4 to monitor discussion as the students decide on a winner. Make sure that Team 4 can present its decision backed with examples and evidence based on notes taken during the debate.

Debate protocol

This is an example debate format designed for an hour-long class period. Please modify this format, the topic and the questions depending on what works best for your class.

Openings:

Overview from Team 4 including Background Questions: 4 minutes

Opening remarks from Team 1: 3 minutes

Opening remarks from Team 2: 3 minutes

Opening remarks from Team 3: 3 minutes

The opening should be a general statement about the team’s viewpoint and the key arguments for that viewpoint.

Questions and rebuttal:

Debate Question 1 Team 1: 2 minutes

Debate Question 1 Team 2: 2 minutes

Debate Question 1 Team 3: 2 minutes

Brief caucus for preparing rebuttal: 30 seconds

Rebuttal Team 1: 1 minute and 30 seconds

Rebuttal Team 2: 1 minute and 30 seconds

Rebuttal Team 3: 1 minute and 30 seconds

Debate Question 2 Team 1: 2 minutes

Debate Question 2 Team 2: 2 minutes

Debate Question 2 Team 3: 2 minutes

Brief caucus for preparing rebuttal: 30 seconds

Rebuttal Team 1: 1 minute and 30 seconds

Rebuttal Team 2: 1 minute and 30 seconds

Rebuttal Team 3: 1 minute and 30 seconds

After each round of Debate Questions, teams will have time for a rebuttal that should consider the following:

Has another team used an incorrect fact?

Has another team used a correct fact but applied it incorrectly?

Has another team failed to support an argument with factual evidence?

Does the team disagree with how another team used a hypothetical situation, ethical principle or societal argument?

What facts seem to disprove another team's arguments?

What hypothetical situation, ethical principle or societal argument seems to disprove another team's arguments?

Closing remarks:

Brief caucus for preparing closing remarks: 2 minutes

Closing remarks from Team 1: 4 minutes

Closing remarks from Team 2: 4 minutes

Closing remarks from Team 3: 4 minutes

Clarifying questions from Team 4, deliberation and final verdict: 10 minutes

For the closing, Teams 1–3 should restate the team's viewpoint, restate the main arguments modified as necessary based on the debate discussion and briefly restate the major objections to the arguments from the other teams. Team 4 should then ask clarifying questions before discussing and presenting its results.

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Teacher Tips for The Great Gene-editing Debate

The following information provides possible viewpoints, opening arguments and Background and Debate Questions and answers for a debate focused on the creation of gene-edited babies, as discussed in the *Science News* article "[Ban on gene-edited babies proposed](#)." Don't let this information limit or narrow what students come up with on their own. When talking to students during the preparation period, encourage them to explore answers broadly before narrowing their focus and answers.

Viewpoints:

Team 1 (pro): Unlimited gene editing for the creation of human babies should be allowed.

Team 2 (intermediate): Limited gene editing in eggs, sperm and human embryos for specific diseases and not for enhancement should be allowed.

Team 3 (con): No gene editing for the creation of human babies for any reason should be allowed.

Team 4 (moderators/judges)

Team 4: Background Questions

1. What is gene editing? Name one technique that has been used to edit genes. What type of gene editing is this debate specifically focused on?

Gene editing is the ability to target specific genes to add, remove or modify them, including in humans, human eggs, sperm and embryos. One gene-editing technique is called CRISPR/Cas9. Using the CRISPR/Cas9 technique, it is possible to delete, add or replace genetic material in a cell, including in germ line cells and embryos that may then develop into an organism. This debate is specifically focused on whether genes that can be passed on to the next generation should be edited.

2. How has gene editing been used so far for the creation of human babies?

At least one scientist, Jiankui He, claims to have produced gene-edited embryos that resulted in babies.

3. According to the *Science News* article "[Ban on gene-edited babies proposed](#)," what is the current thinking on whether creating gene-edited babies should be allowed?

Many scientists and officials have called for a five-year moratorium on creating gene-edited babies to sort out the technological and ethical issues. At least one scientist, however, has gone forward with it.

Teams 1–3: Arguments and Debate Questions

After the teams state their opening remarks, they will make the main arguments for their viewpoints. Sample arguments include:

Team 1: Unlimited gene editing for the creation of human babies could eliminate genetic diseases and disease predisposition from the gene pool. It could make children as intelligent, strong and attractive as possible.

Team 2: Limited gene editing for the creation of human babies could save children from being born with serious genetic diseases and allow people with serious genetic diseases to have children without fear of passing on their genetic problems. At the same time, limited gene editing would not alter what it means to be human, or allow some people to make their children “superior” to others.

Team 3: We oppose all gene editing for the creation of human babies because the risks are too high that gene editing may cause harmful unintended side effects. Because of the costs of gene editing, there are risks that gene editing for the creation of human babies could lead to a class of genetic “haves” and “have-nots.” There are also risks that the technology could be misused to mutate, enslave or wipe out humanity.

Sample Debate Questions include:

Question 1: How should the scientific community proceed at this point in time?

Team 1: The scientific community should monitor the first gene-edited babies for any signs of problems. It should continue to improve gene-editing techniques and applications, and test those in humans as soon as possible.

Team 2: The scientific community should investigate the accuracy and safety of gene-editing techniques, and improve techniques if necessary. The scientific community should continue to investigate various applications of gene-editing technology in human eggs, sperm and embryos and should focus research on serious genetic diseases. Once a consensus is reached within the community that a technique is safe, scientists should begin using it.

Team 3: The scientific community should continue to develop and test gene-editing technologies, but only apply those to organisms other than humans, or to human cells and tissues that cannot develop into new humans or pass on genetic information to the next generation.

Question 2: How should national governments proceed at this point in time?

Team 1: National governments should allow the creation of gene-edited babies. They should also fund the development of improved methods and new applications for gene editing. Governments should consider trying to beat other countries at a “genetic arms race” to make as many of their future citizens as healthy, as intelligent and as strong as possible, in order to maximize their economic competitiveness in the coming decades.

Team 2: National governments may want to ban the creation of gene-edited babies for a few years until the safety and accuracy of gene-editing technology has been optimized and proved. After that time, governments should allow the use of gene-editing technology to correct serious inherited genetic diseases, but not to make other heritable genetic improvements. In order to decide which specific human applications should be allowed and which should not, governments should set up panels of scientific, ethical, legal,

political and religious experts to establish specific guidelines, or to review proposed applications as they come up.

Team 3: All national governments should ban the creation of gene-edited babies. Governments should make sure that such work is not being carried out in secret. Governments may allow and even fund the development and use of gene-editing technologies for other applications though, such as combating pathogenic diseases, improving agriculture and so on.

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Debate Preparation Sheet

Directions: After your teacher has assigned teams and viewpoints for the upcoming debate, read through the team roles and debate protocol. Then read through the debate preparation section answering as many questions as you can in advance of the debate. You can also use this section to take notes during the debate and prepare your rebuttal and closing remarks.

Team roles

All students should become familiar with the debate protocol and focus on their team's speaking assignments. Pay close attention to the amount of time allotted to prepare and speak for each section of the debate. Each student in a group should prepare to speak during the debate. All team members must speak before a team member can speak a second time.

Using the debate preparation questions below, Teams 1–3 should research and prepare a general opening argument and answers to the Debate Questions, which will be asked during the debate. You'll also want to do enough background research for possible rebuttals and a closing argument that aligns with your viewpoint. Be prepared to speak confidently about your viewpoint. You may want to prepare notecards that capture your speaking points.

Team 4 will be responsible for monitoring, moderating and judging the debate. Using the debate preparation questions below, members of Team 4 will introduce scientific concepts by answering the Background Questions, moderate the debate by asking questions, keep track of speaking time per team, take notes throughout the debate and present the debate results and reasoning.

After all groups have presented their closing arguments, Team 4 will convene with the teacher to decide on a winner. Teams 1–3 should be evaluated based on the persuasiveness of their arguments, and how much those arguments are based on scientific fact. Team 4 should use notes from the debate to prepare and present an explanation of the decision using examples and evidence.

Debate protocol

Openings:

Overview from Team 4, including Background Questions: 4 minutes

Opening remarks from Team 1: 3 minutes

Opening remarks from Team 2: 3 minutes

Opening remarks from Team 3: 3 minutes

Questions and rebuttal:

Debate Question 1 Team 1: 2 minutes

Debate Question 1 Team 2: 2 minutes

Debate Question 1 Team 3: 2 minutes

Brief caucus for preparing rebuttal: 30 seconds

Rebuttal Team 1: 1 minute and 30 seconds
Rebuttal Team 2: 1 minute and 30 seconds
Rebuttal Team 3: 1 minute and 30 seconds
Debate Question 2 Team 1: 2 minutes
Debate Question 2 Team 2: 2 minutes
Debate Question 2 Team 3: 2 minutes
Brief caucus for preparing rebuttal: 30 seconds
Rebuttal Team 1: 1 minute and 30 seconds
Rebuttal Team 2: 1 minute and 30 seconds
Rebuttal Team 3: 1 minute and 30 seconds

Closing remarks:

Brief caucus for preparing closing remarks: 2 minutes
Closing remarks from Team 1: 4 minutes
Closing remarks from Team 2: 4 minutes
Closing remarks from Team 3: 4 minutes
Clarifying questions from Team 4, deliberation and final verdict: 10 minutes

Debate preparation for Teams 1–3

What is your team's viewpoint?

Briefly list your main arguments for that viewpoint.

Debate Question 1: How should the scientific community proceed at this point in time?

Debate Question 2: How should national governments proceed at this point in time?

What arguments do you expect the other teams to make and how will you respond to them during your rebuttal time?

For your rebuttal, consider whether another team done any of the following. If so, explain.

Used an incorrect fact.

Taken a correct fact but applied it incorrectly.

Failed to support an argument with factual evidence.

Used a hypothetical situation, ethical principle or societal argument inappropriately.

What facts seem to disprove another team's arguments?

What hypothetical situation, ethical principle or societal argument seems to disprove another team's arguments.

During your closing remarks, you will want to restate your team's viewpoint and briefly restate your main argument for that viewpoint. Have you modified your viewpoint based on the discussion during the debate?

What are your major objections to the arguments from the other teams?

Debate preparation for Team 4

Your team will give an overview to open the debate by answering the following Background Questions:

1. What is gene editing? Name one technique that has been used to edit genes. What type of gene editing is this debate specifically focused on?
2. How has gene editing been used so far for the creation of human babies?
3. According to the *Science News* article "[Ban on gene-edited babies proposed](#)," what is the current thinking on whether creating gene-edited babies should be allowed?

During the debate, make notes about the other teams' arguments.

What have you found most persuasive about the arguments?

Team 1

Team 2

Team 3

What did you find least persuasive?

Team 1

Team 2

Team 3

What questions do you need answered to clarify your understanding?

Team 1

Team 2

Team 3

Explain which team you found most persuasive and why. (Remember: You are not judging based on your personal beliefs but rather based on your observations of which team made the most effective arguments for its viewpoint and the most effective arguments against the viewpoints of the other teams.)

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Related Articles

Science News:

[“Most Americans think it’s OK to tweak a baby’s genes to prevent disease,”](#) Readability: 11.0

[“A Nobel Prize winner argues banning CRISPR babies won’t work,”](#) Readability: 11.9

Science News for Students:

[“Explainer: How CRISPR works,”](#) Readability: 6.9

[“Can DNA editing save endangered species?”](#) Readability: 6.6