CRISPR and Genetic Engineering: Innovation, Bioethics, and Public Policy

Lesson Length: 2 class periods

Grade Levels: 11th–12th

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Overview

Students will first explore the science behind CRISPR-Cas9 (or CRISPR) and understand its role in gene editing. They will then analyze multiple perspectives on regulating CRISPR's use, particularly in agriculture and food production, through case studies and articles that present varying viewpoints. This will lead to an examination of real-world regulations and policy debates, allowing students to weigh differing perspectives while practicing civil discourse strategies, such as a structured academic controversy, to address the ethical dimensions of genetic engineering and the role of federal agencies. The lesson concludes with an optional independent extension project, where students analyze controversial CRISPR applications to explore societal impacts and the regulatory landscape.

This lesson aligns with Advanced Placement Biology Unit 6: Gene Expression and Regulation. It connects to advanced biological concepts in the unit and engages students in ethical debates and civil discourse strategies alongside independent research and synthesis of information.

The lesson can be adapted for 10th-grade honors biology, such as by simplifying the teaching of CRISPR mechanisms, reducing the depth of discussion on ethical issues in genetic engineering, and focusing more on basic pro/con discussions with visual supports.

The lesson is also suitable for government, economics, environmental science, ethics, or other advanced subjects to help students identify interdisciplinary connections.

Objectives

- Define CRISPR and explain how it is used to edit genes in various organisms
- Analyze text to gather evidence to support claims about how the government regulates the use of CRISPR and other genetic engineering technologies

- Evaluate and discuss the ethical and regulatory implications of using gene-editing technologies, considering both public policy and consumer impact

Vocabulary

- Regulation
- CRISPR
- Genetic engineering
- DNA
- RNA
- Organism
- Bioethics
- Genetically modified organism (GMO)
- Public policy
- Federal agencies (US Department of Agriculture, Food and Drug Administration)

Materials

- Prework graphic organizer
- Andrea M. Henle, "How CRISPR Lets You Edit DNA by TED," TED-Ed, YouTube video, 5:28
- Jennifer Doudna, "How CRISPR Lets Us Edit Our DNA," TED, YouTube video, 15:53
- "FDA's Regulation of Plant and Animal Biotechnology Products" Food and Drug Administration, last updated April 17, 2025 (printed or digital for optional warm-up extension)
- "Secretary Perdue Issues USDA Statement on Plant Breeding Innovation," press release, Department of Agriculture, March 28, 2018 (printed or digital for optional warm-up extension)
- Global Gene Editing Regulation Tracker, Genetic Literacy Project (digital)
- Surprising, Interesting, Troubling (SIT) chart
- Thomas A. Hemphill and Syagnik Banerjee, "Mandatory Food Labeling for GMOs," *Regulation*, Cato Institute (Winter 2014–2015) (printed or digital for lesson activity)
- "Court Rules 'QR' Codes Alone Unlawful for GMO Food Labeling," Center for Food Safety, September 14, 2022 (printed or digital for lesson activity)
- David J. Bertioli and Henry I. Miller, "The Inhibition of Innovation," *Regulation*, Cato Institute (Fall 2023) (printed or digital for lesson activity)
- Temesgen Deressa et al., "Genetically Engineered Crops: Key to Climate Adaptation and Food Security in Africa?," Brookings Institution, September 4, 2014 (printed or digital for lesson activity)
- Lesson graphic organizer

- "Gene Editing Produces Non-Browning Avocado," ISAAA Inc., June 14, 2023 (printed or digital for lesson activity)
- Sticky notes or paper (optional; can be replaced with a digital version)
- Laptops and internet
- Pencils/pens and highlighters (optional for the articles)

Prework (30 minutes to 1 hour)

Teacher's note: To engage in this lesson, students will benefit from preexisting knowledge on basic genetics and cell biology. This includes understanding the functions of DNA and RNA and how proteins function, along with genes and how genetic information is inherited.

Additionally, before entering conversations about challenging topics with students, we encourage you to create discussion norms as a class. We recommend using our editable Class Norms Document and Healthy Discussion Norms poster as starting points. As you prepare to guide students in discussion, leverage our Fostering Civil Discourse in STEM Classrooms: Tips and Tricks resource to identify meaningful ways to engage with students.

Before the lesson, have students learn or review how CRISPR allows for genetic engineering. Showing one or both videos is a way to introduce or review the use of CRISPR. Although there are some examples of human DNA editing, this lesson focuses on agricultural impacts, with an optional extension to explore further case studies of genetic engineering. Watch "How CRISPR Lets You Edit DNA," by Andrea M. Henle (5:28), or "How CRISPR Lets Us Edit Our DNA," by Jennifer Doudna (15:53). The first video is a short, visually engaging overview that uses graphics to provide a concise and accessible explanation of how CRISPR works. The second video is a longer talk by the cofounder of CRISPR offering a deeper dive into the science behind the technology, supported by visuals and briefly addressing ethical implications.

Let students know that as they watch the videos, they should use the graphic organizer to record what they understand so far and questions or wonderings they have.

Prework notes: CRISPR	
Question	Notes
How does CRISPR work to modify genetic material?	
What are some ways CRISPR is being used?	

What are the potential benefits or risks?	
What questions or concerns do you have on gene-editing technologies being used in agriculture or medicine?	

In a brief discussion or shared as written key points, review key ideas:

CRISPR is a gene-editing tool that uses a guide RNA to direct the Cas9 enzyme to a specific DNA sequence, where it makes a cut. This allows scientists to add, remove, or repair genetic material. This technology has been used in applications such as creating disease-resistant crops and developing potential cures for genetic disorders such as sickle cell anemia.

Day 1

WARM-UP (15 MINUTES)

PART 1

Step 1: Provide the following quick writing prompt to students: "If you could use CRISPR to edit a gene in any organism, what would you change and why?" Give students 3 minutes to write their responses independently.

Step 2: Have students pair up to share their ideas. Introduce a follow-up question for deeper reflection: "What are the ethical implications of your gene edit? What are the possible pros and cons?" Encourage partners to build on each other's thinking, identifying potential impacts or concerns they may not have considered alone.

Step 3: Welcome students back to a whole-group discussion and ask for volunteers to share a few key thoughts.

PART 2

Step 1: Transition to the second part of the warm-up by briefly sharing and discussing background information about regulations from the Food and Drug Administration (FDA) and the US Department of Agriculture (USDA):

> Regulations are rules created by federal agencies to ensure laws passed by Congress are properly carried out, often reflecting the agency's interpretation of how to implement

those laws in practice. The FDA and the USDA are two such agencies responsible for regulating food and agricultural products. The FDA oversees regulations of food produced using biotechnology, such as genetically modified or gene-edited (like those by CRISPR) crops, while the USDA monitors how crops are grown and whether they pose risks to plant health or the environment.

Plants edited with CRISPR—where no foreign DNA is introduced—are not subject to the same FDA and USDA regulatory oversight as traditional genetically modified organisms (GMOs), meaning they may move through the regulatory process more quickly. While the FDA does not approve GMOs or genetically engineered foods in the same way it does with medicines, it issues guidance and may intervene if there are safety concerns or labeling issues.

You may wish to spend more time on the warm-up by allowing students to read resources from "FDA's Regulation of Plant and Animal Biotechnology Products" or "Secretary Perdue Issues USDA Statement on Plant Breeding Innovation." They may also explore the Global Gene Editing Regulation Tracker by the Genetic Literacy Project in the Optional Extension Project 2.

Step 2: Ask students to consider what is surprising (S), interesting (I), or troubling (T) to them about regulations of CRISPR use in agriculture and food production. Have them reflect on this question as they contribute to the whole-group chart:

> "To what extent should the use of CRISPR in agriculture and food production be regulated?" The basis of regulations can be compared with the current GMO regulations.

Proceed as a class to fill out the SIT chart based on the background information and discussion.

Surprising	Interesting	Troubling
What do you find surprising about current regulations of CRISPR-edited plants and/or GMOs?	What do you find interesting about the regulations surrounding CRISPR in agriculture and its comparisons to GMOs?	What do you find troubling about the current levels of regulations with CRISPR and/or GMOs?

Step 3: Tell students that in today's lesson they will be exploring viewpoint-diverse articles on perspectives regarding regulations of GMOs; ask them to consider how, or if, CRISPR-edited foods should be labeled or regulated using an example of CRISPR-edited nonbrowning avocados.

The students' goal in engaging in text analysis will be to identify the reasoning for the different perspectives and to build their own opinions regarding the impacts of agriculture and food regulations and policies. In Day 2's activity, students will share arguments in a structured discussion strategy, a structured academic controversy.

Lesson Activities (35 minutes)

ACTIVITY 1—TEXT ANALYSIS (30 MINUTES)

Teacher's note: It may be helpful to guide students in exploring the role of rhetoric—recognizing that what they read is shaped by not only the author's rhetorical choices but also their own perspectives and interpretive lens. To support this, consider using the Rhetoric and Civil Discourse Module, which includes lessons on concepts like The ABCs of Rhetoric and Terministic Screens.

Step 1: Provide the articles to students and divide them into small groups. Within each group, assign 1 article to each student so that all 4 articles are covered; students will read and analyze their assigned article independently before discussing it together in a jigsaw format.

Step 2: Have students use the graphic organizer below to organize notes and reflections on their assigned article using text evidence.

Regulations of GMOs and connections to CRISPR			
Article	How does the text frame the role of government regulation in GMO labeling?	What does the article reveal about the potential intended or unintended consequences of regulations on consumers and the food and agriculture industries?	How can the debate over GMO regulations presented in these articles serve as a case study for informing the degree to which CRISPR technology should be regulated?

"Mandatory Food Labeling for GMOs" Sections: *Pros and Cons* *Consumer Perceptions* *Politics and Labeling*			
"Court Rules 'QR' Codes Alone Unlawful for GMO Food Labeling"			
Barriers and impacts of innovation			
Article	How do the authors frame the role of genetically engineered crops in addressing societal challenges?	How do the authors describe the impact of regulation policies on the development and adoption of genetically engineered technologies?	
"The Inhibition of Innovation"			
"Genetically Engineered Crops: Key to Climate Adaptation and Food Security in Africa?"			

Step 3: Have students share their findings about their article in their small groups. After each student has had a chance to share, have the small groups revisit the following question: "To what extent should the use of CRISPR in agriculture and food production be regulated?"

ACTIVITY 2—APPLY LEARNING TO AN EXAMPLE (5 MINUTES)

Step 1: In the small groups, have them collaborate and apply their learning to an example: What, if any, regulations should be applied to CRISPR-edited nonbrowning avocados, and why?

Step 2: Ask students to share their findings and engage in a brief whole-group discussion. Have small-group reporters share their group's consensus (or lack thereof) on the case of the nonbrowning avocados.

ACTIVITY 3—SIT REVISITED AND PREVIEW OF DAY 2 (5 MINUTES)

Step 1: Direct students back to the SIT chart. Ask several students to share how they would revise or add on to what they find surprising, interesting, or troubling, using evidence from their text analysis.

Step 2: Explain to students that on Day 2, they will engage in a structured academic controversy in which they will discuss the pros and cons of federal regulations of genetically engineered agriculture and food products with the following central question:

> "To what extent should gene-editing technologies in agriculture and food production be regulated?"

Preview this question and share with students that they should come prepared to discuss perspectives using evidence from the texts they analyzed with their peers.

Exit Ticket (5 minutes)

Ask students to revisit their original warm-up response: "If you could use CRISPR to edit a gene in any organism, what would you change and why?" Ask them to add how, or if, the federal government would regulate the use of CRISPR in their example.

DAY 2—STRUCTURED ACADEMIC CONTROVERSY

Teacher's note: For more information on this discourse strategy, or to learn about others you may use, refer to "11 Civil Discourse Strategies to Try in Your Classroom." (Structured academic controversy is no. 9 in the list.)

Warm-Up (5 minutes)

Have students connect to learning and discussions from Day 1 by doing a recap with a partner using think-pair-share to discuss the following questions:

1. What is CRISPR, and how is its use regulated by the federal government? How does this compare to GMOs?
2. Explain different perspectives on how genetically engineered agriculture and food products should be regulated.

Lesson Activity (50 minutes)

Step 1: Have students recall your class community norms. Emphasize that the purpose of the activity will be to listen to understand both sides of the issue and engage in civil discourse, not to win a debate. *If you did not do this during the prework section, this would be a great time to set a goal of 3 norms to maintain before entering discussion, or you can embed this during the warm-up.*

Step 2: Ask students to engage in a structured academic controversy about the following question:

> "To what extent should gene-editing technologies in agriculture and food production be regulated?"

Steps of the structured academic controversy:

1. Divide students into groups of 4, where 2 students will take a stance of stricter regulation (Team A) and 2 take the stance of less regulation (Team B). Each partner set within the group will prepare 2–3 key points. Students should use examples from the articles on Day 1 to support their stances (10 minutes).
2. Engage in 3 timed rounds, each lasting 5 minutes (15 minutes): Round 1—Team A will present their case while Team B listens and takes notes. Round 2—Team B will present while Team A listens and takes notes. Round 3—Open rebuttal will take place, where each team asks clarifying questions and responds to one another.
3. For 2 final 5-minute rounds, each team will switch stances and try to present the opposite stance (10 minutes).
4. The small group will then engage in collaboration to identify common ground, list any remaining questions and concerns, and propose a consensus or policy suggestion (10 minutes).

Step 3: Close the discussion by encouraging students to share reflections on the structured academic controversy process. Encourage further exploration of gene-editing technologies and highlight how ethics, scientific innovation, and public health shape decisions around regulation and policy in agriculture.

This discussion will serve as a step to exploring even more complex questions about the use of gene editing in animals and humans, especially in medical contexts, where ethical, social, and scientific challenges become even more significant.

Exit Ticket (5 minutes)

Prompt students to reflect on how CRISPR and genetic engineering are connected to not only scientific advancement but also public policy decisions, economic factors, consumer choices, and impacts on health care. On a sticky note, paper, or virtual discussion board, jot down in bullet points or short sentences:

1. What surprises you about how these areas influence one another?
2. Did you notice any unexpected connections between gene editing, regulations, and real-world impacts?

Optional Extension Project 1: CRISPR Cases

Have students independently or with peers select a case study where CRISPR has been used and created controversy.

Examples could include but are not limited to:

- Genetic engineering in animals (e.g., pets, editing for traits of extinct animals, or mosquitoes to prevent malaria)
- Medicinal cases (e.g., sickle cell anemia or gene-edited pig organs for transplants).

Ask them to apply their knowledge from this lesson to examine and create a report or presentation on the following:

1. Explain how CRISPR was used in the case and if it was successful.
2. Explain the current regulations, if any, governing the use of CRISPR in this case and the role (or lack thereof) of federal agencies.
3. Evaluate the intended and unintended consequences of using CRISPR in this case. Consider access, consent, safety, and other implications.
4. Propose a potential policy approach, and explain the extent to which you believe gene editing should be regulated in this case, supporting your position with evidence and reasoning.

Have students share their case study and responses with the class. You may wish to lengthen the extension by having students discuss these cases using another discourse strategy, such as a fishbowl or Socratic Seminar.

Optional Extension Project 2: Global Genetic Engineering Policies

Have students work independently or in small groups to explore how different countries approach the regulation of genetic engineering using the Global Gene Editing Regulation Tracker by the Genetic Literacy Project and other research sources.

Ask students to select 2–3 countries with varying regulatory approaches (for example, 1 with strict regulation, 1 with moderate or evolving policies, and 1 with permissive policies).

Have students research and create a comparison report, matrix, or presentation that addresses details by doing the following:

- Summarize each country's current stance on gene editing in various fields, such as research, agriculture, and medicine.
- Identify which government or science agencies are responsible for oversight and enforcement and how these compare with the United States.
- Analyze how cultural, political, or ethical values influence each country's regulation.
- Discuss the implications of differing policies on global collaboration and innovation.
- Propose how international cooperation or standards might help or hinder cross-border challenges in gene editing.

For deeper engagement, you may wish to conclude with a civil discourse activity after project presentations. For example, a fishbowl discussion could explore the implications of global collaboration on gene editing with a question such as, "To what extent should gene-editing technologies in agriculture and food production be regulated across different countries?"

Note: Although it doesn't cover genetic engineering, the lesson "Your Life in Numbers" provides students with the opportunity to use global comparison data on various development indicators. You may find it useful to integrate activities from this lesson to provide broader context on how countries differ in policies, infrastructure, and quality of life.