

Bringing the Ethical Debate to Life: A 3 Dimensional Lesson About Gene Editing

Vocabulary and Word Bank

Engage science, science fiction, public, responsibilities
Explore inherit, trait, disease resistant, heterochromia, desired traits, selected, society, desirable for society, advantage, advantageous trait, organism, observable, not observable, gene, genome, set of genes, express, expression, gene editing, CRISPR, technology, influences, increase the probability, inheritance, edit
Explain genes, creation, expressed those genes, codes that increase the likelihood, instructions, express a physical trait, genetically decrease the likelihood, gene editing, genome, code for, innovation, generation, cells, high chance, future, human influence, expressed, cause, effect
Explain an Out-of-Control Creation impact on society, responsibilities as scientists, justify, credit, debate, different perspectives, scientific innovation, society, ethics
Elaborate lab assistant, DNA, abnormal, contamination, chemicals, experiment, hacked DNA, eradicate disease, reliable information, consider different perspectives, form arguments, role play, character's perspective, beliefs, values, affect children, who should decide, represent, motives, genetic disorders, trust, enhance abilities, get permission, evaluate quality of arguments, ethics
Evaluate policymaker, communicate, evaluate, perspective, claim, credible, effects on society, risk, benefit, cause and effect

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Safety and Materials Lists

In our implementation, we chose to have each pair of students make a genome and a creation. However, to reduce the managerial complexity and cost, teachers could have each group of 3 or 4 students create a genome and a creation as a group. Teachers could also reduce the managerial complexity and cost by reducing the variety and number of craft materials.

Safety Procedures

- Alert students that small items (such as googly eyes) may pose a choking hazard.
- Use safety goggles during the construction and testing of the creation (scribble-bot) because there is potential for projectiles.
- Use poster-size paper (or larger) with the creations (scribble bots) because the markers may stain furniture or clothing. It is also recommended that the paper be taped to the table to prevent stains.
- Closely monitor the use of batteries because they contain chemicals.
- Check for student allergies related to polyethylene foam (in the pool noodles) or in the other craft materials (rubber bands, glue, etc.).
- Use safety scissors or closely supervise all-purpose scissors
- The teacher should cut the pool noodles (using large scissors, a serrated bread knife, or a saw) to 6 inch lengths prior to the lesson.

Materials List

Science Notebook Activity Sheets: One for each student, total for class = 30 each

Forms available in online supplementary materials

Creating the Genome: One for each pair of students: total for class = 15 sets

- Human genes: a small plastic baggie containing 4 puzzle-piece sticky notes (4A shapes puzzle, 2 7/8 X 2 4/7 inches, self-stick, assorted colors)
- Non-human genes: a small plastic baggie containing 4 square sticky notes (3 x 3 inches, self-stick, assorted colors)

Expressing the Genome: One tub of assorted craft supplies for each group of students (two partners form a group of 4 students), total for class = 7 or 8 tubs

- Pool noodle, cut to 6 inches length: 2 (available at discount stores, they can be cut by an adult into 6" pieces using large scissors, a serrated bread knife, or a saw.)
- Craft googly eyes: 6 (at least two different colors)
- Craft feathers: 5
- Craft chenille stems: 15 (also called pipe cleaners, assorted colors)
- Stickers that look like little brains, hearts, noses, ears, etc.: 2
- Popsicle sticks: 6
- Straws: 5 (assorted colors)
- Foam sheets: 5 (assorted colors)
- Shredded paper
- Paper: 10 sheets (construction, gift wrapping, assorted colors, etc.):
- Fabric scraps or ribbon
- Safety scissors: 4
- Tape: 1 roll double sided, 1 roll regular
- School Glue: 1 bottle

Bringing the Creation (Scribble-Bot) to Life: One for each pair of students: total for class = 15 sets

- Thin markers: 3-4 (A larger or worn out tip on a marker can cause a creation to catch on the surface of the paper)
- Thin rubber bands: 2 (the thick ones did not work well for this task)

- Battery operated electric toothbrushes (1 per pair, can be purchased at discount stores. Get the kind with a vibrating head, not a rotating head. Inexpensive ones can be found at a drug store or dollar store, and seem to work better for this activity than some costlier options. It is more convenient if the on/off switch is on the butt end of the toothbrush rather than along the handle (that way, the switch is exposed when the toothbrush is inside the pool noodle). Remove the motor and battery compartment from the toothbrush. The entire toothbrush can be used for the activity but it adds weight that makes the balance and movement more challenging.
- AA batteries (one pair for each pair of students)
- Large sheet of white paper or large roll of butcher paper to cover an entire table or tape onto the floor so that several creations (scribble-bots) can scribble at once. Be sure to use a smooth flat surface such as a table or a smooth floor (not carpet).

An Out-Of-Control Creation (Scribble-Bot) to Life: One for class

- White shirt to role-play that the creation (scribble bot) drew on a shirt or other garment. A white shirt can be purchased at a thrift store and prepared before the lesson.



Debate: one set for each group of 4 to 5 student

- Set of character cards copied and folded – Scientist : 2 sets of 5 cards = 10
- Set of character cards copied and folded – Creation : 2 sets of 5 cards = 10
- Set of character cards copied and folded – Public : 2 sets of 5 cards = 10

(Character card documents available in online supplementary materials)

Summative Assessment: One for each student, total for class = 30 each

Forms available in supplementary materials – teacher's guide)

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Make a Creature

1. Build the body. Use rubber bands to attach three or four markers to the pool noodle. These will be your creature's legs. The drawing tips of the markers should point down and extend past the bottom of the tube.



2. Now add craft pieces to express the sets of genes from the genome you created.



3. Place the motor in the opening inside the pool noodle. Uncap the markers. Place the creature on paper. Turn on the motor.



Tips: If you use pieces of paper instead of covering the table, be sure you place the sheet of paper and the creation in a tray. This will keep the creation from skittering off the paper and writing on the

table.

If a creation gets stuck in one position, make certain that you are using a flat smooth surface and fine-tip markers. Sometimes a larger or worn out tip on a marker will cause a creation to catch on the grooves of the table or tray. You can also try adjusting the position or angle of the creation's legs to make it move better.

Summative Assessment

Prompt: Letter about Gene Editing

A policymaker sets rules in society.

Write a letter to a policymaker. In the letter

Tell what genes are

Tell what gene editing is

Tell how gene editing might impact society (good, bad, both). Evaluate.

Communicate more than one perspective about the effects of gene editing

Take your position about what to do. Support your stance.

Summative Assessment Rubric

Category	0 - 1	2 - 3	4 - 5
DCI Science of genes and gene-editing	Does not tell how genes or gene editing function. Many misconceptions about how humans might be involved or how genes or sets of genes function.	A partial description of genes and gene editing is given. Tells how genes impact the inheritance of traits in organisms. May have one or two misconceptions about how humans are involved, how genes or sets of genes function such as saying that genes cause traits instead of saying genes cause the likelihood of traits being expressed	A description of genes and gene editing is complete and correct. Tells how humans can influence the inheritance of desired traits in organisms.
CCC Cause and Effect	Does not address how genes are involved in genetic outcomes. Does not address how gene editing may impact society (lacks cause and effect reasoning).	Describes a connection between sets of genes and traits of organisms. Begins to describe how gene editing might impact society but may be narrow in scope, focusing only on effects inside a laboratory or how the student and their immediate surroundings might be impacted	Describes how sets of genes increase the likelihood to a trait. Describes how gene editing might impact broader society (shows cause and effect reasoning).
SEP Evaluate information	Does not provide a perspective on the issue. Does not portray themselves with agency to understand, evaluate, or take a stance on the issue	Takes at least one evaluative perspective on the issue. Begins to display agency in understanding and discussing this issue.	Considers at least two perspectives about gene-editing (public, scientists, people affected). Shows agency in discussing , evaluating, and impacting the issue.
SEP Communicate information	The writing and argument does not make sense or is unclear. May argue from sources that are not credible.	The argument is understandable and begins to use credible sources. Begins to show logical reasoning with supporting information.	The argument is well explained and logical. Synthesizes credible and relevant sources which may include reference material and class discussion.
Creativity and	The argument is disconnected and / or unoriginal.	The argument shows some creativity, connects more than one idea, but may rely heavily on re-	The argument is unique, uses ethical reasons, and

Coherence		stating supplied information	shows synthesis of information
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A Student's Summative Assessment Example

Dear Policymaker,

I am writing to tell about genes and gene-editing. I will also tell my opinions.

Genes are what pass down something like eye color from generation to generation. Genes get passed down through cells. Genes are parts of your body that you can't see. A gene is a set of codes that creates a human or a creature, for example arms. Genes give instructions to make the body like giving eyes color.

Genes could be edited. Gene editing can change genes to different genes. Cutting genes is CRISPR. Gene editing can fix genes. Gene editing can make it so people can make new and improved stuff, be creative. It can also cause a mess.

Gene editing could make it so people don't get sick. So they are at peace. It can fix things. It could find cures. It could make things be different. Different is not bad.

It can be harmful because someone can be destructive and be bad. Someone can do bad things. Someone can control it. It could give too much strength. It might do something wrong. The scientist should take responsibility because they change the DNA. Gene editing could cause death or the opposite of what you want to happen.

As the public we should have rules. We can have problems. We want the future to be good. We want for new cures be discovered. But we want to be safe and fair. We don't want to be tested on. We don't want to let our children be tested on. What if you didn't test it on humans? Test it another way. Gene editing is not always a bad thing. It has risks.