



THE SCIENCE

How does this biotechnology work?
 Try to incorporate ideas that have been explored in class.
 Be sure that the language you use is grade-level appropriate.

- > **Gene drives**
 - o Violates Mendelian Genetics
 - Says when a male & female mate the offspring receives ½ it's dna from the male & ½ from the female.
 - What happened was all the offspring of the 1:15 (2:30) ratio has the trait from the minority other than the other.
 - o They used CRISPR
 - o **Problems**
 - How to get the trait to spread?
 - **The gene drive**
 - o Perpetual motion machine for passing on genes
 - Will automatically copy and paste the new gene into both chromosomes (science terms) Heterozygous -> Homozygous
 - The gene drive works too well, natural selection will not work
 - The gene drive will not stop spreading the gene until every one of the offspring has the gene.
 - And accidental relise could cause the change of an entire species – quickly
 - With the modern economy species can get transported to places where they do not belong
 - i.e, how we have non native, invasive species.
 - Insects & animals that fly, can go across oceans / borders / etc... on their own.
 - No way to contain them
 - Might not stay confined to the *target species*
 - Gene flow / interbreeding
 -
 - o **Benefits**
 - 1% can become 100% in one year (using mosquitos)
 - You can also change the sex of the offspring
 - This depends on how fast the species reproduces
 - o **Precautions**
 - Bio-containment labs
 - Species that are not native to the country, so natural selection will wipe them out.
 - You can make a reversal drive
 - Something that can over ride the original trait.
 - o Cancel
 - Gene drives that become less prominent after each generation
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 - o **Worries**
 - Anyone can do it
 - Undergrad, talented high school student
 - o **Rules**
 - They only work on sexually reproducing species
 - ((can't be used for viruses or bacteria))
 - The trait spreads only with offspring
 - The faster the reproductive cycle
 - o For humans it could take centuries for a trait to take over.
 - You need to figure out which genes do what, then change them
 - o **Who says humans get to change entire species?**
 - o **Countries could not agree on if to release a gene drive**
 - o

Ethics Planning Template

DILEMMA
See reverse.

Group members: Rachel S & Megan

THE SOLUTION

How can society adapt to the integration/implementation or advancement of this technology?

- All countries need to be with agreement of eachother
 - o The countries should consult scientist/ experts so they are certain reliseing a certain gene drive is the correct thing to do.
- It should be okay to edit genes, if it is going to benefit humanity and the world.
 - o It should not be used for unessessary circumstances, such as looks.
- CRISPR is still very new
- Once we do it we can't go back
- It might not work in nature
- The embryo may still carry the mutation
 - o Some cells have the correction
 - o Some cells have the mutation
 - To avoid genetically mosaic embryos, they injected the sperm and oocyte with the correction
- Society will accept or reject the advancement of this technology
- Society may become healthier as genetic diseases are eliminated
 - More money for the governments as health care costs goes down
 - More money in the peoples pockets as they will dispense less money on medication and hospital trips

CONSEQUENCES

What are the benefits? Who is helped?

- 1) This technology (the gene drive) could revolutionize the field of disease control and elimination. One of the more common examples in the mosquito, they are responsible for the transfer of illnesses such as yellow fever, Japanese encephalitis, Saint Louis encephalitis, Ross River fever, Barmah Forest fever, and one of the more well known ones, malaria. (All these are transferred through the blood which the mosquitoes carry.) the gene drive could be used to stop mosquitos from getting / transferring malaria. This could save the lives of an average million people every year.
- 2) This technology (the gene drive) could help species who are being wiped out by other invasive species. The gene drive could be placed into an invasive species and would control the offspring of said species by only making the certain species produce male / female offspring. Thus wiping out the invasive species.

The people who would be most helped are people in hot climates where malaria thrives and people who don't have access to proper medication. Many diseases can be irradiated by simply adding the antibody gene into the animals who spread them.

What are the risks? Who is hurt/at risk?

- 1) It could wipe out the wrong species. since there is inbreeding between similar species. (fish (karp, salmon, etc...)) if one type of the species is meant to be "erased" you could end up "erasing" the entire population of that species in that one area.
- 2) (Linked to the one above) with the modern economy, animals are being transported between countries (more than they should be), of one country is trying to erase a type of fish that is not native to the location, said fish with the gene drive could go to it's native country and erase their population of the species.
- 3) It could be used for wrong, other countries could release a gene drive that could remove one of the resources the country relies on (agriculture, etc...) which could ruin the economy of the country (see this if possibly already ->)
- 4) (Related to the one above) it could cause another world war...

AUTONOMY

Should individuals have the right to choose for themselves, or does one decision count for everyone?

- There is a chance it could be used on people, though unlikely. If so it would take a long time (centuries) for it to populate most / all the population.
 - o Then people would likely have to choose for their offspring.
- For animals they would get no choice because the methods of communication between animals and humans are limited.
- There could be conflict between countries on the release of a gene drive, since it could affect everyone, (flying animals, illegal animal exchange between citizens of different countries.

TED-Talk: Gene editing, & how it could change an entire species FOREVER!
Gene Editing Can Now Change an Entire Species — Forever
Dilemma: - Jennifer Kahn

Should humans be given the power to edit / change an entire species — forever ?

- For people who believe that people should not change nature, this could be problematic.
- For those who believe in a god, they may believe tampering with nature could be considered a sin.
- Manipulating DNA may be related to manipulating life, god does not wish for this to happen.
- Since you are changing the embryo, you are not asking it's perspective.
 - o This can be related to abortion, and how people are against it

the Vatican said in 2002 that "germ line genetic engineering with a therapeutic goal in man would in itself be acceptable" This is if we don't lose embryos

- Some people view gene editing as interrupting with nature
 - o The more devout people are the less likely they're to edit the Child's genes
- We are assuming power that was only intended for god
 - o Ronald Cole-Turner dismissed this claim about god
 - o It's not like god to up this big don't do this sign
 - o Life and creation is a gift that humans should have a certain amount of responsibility with

What perspectives do groups with other cultural, spiritual, or religious views have?

OTHER VIEW POINTS

RIGHTS AND RESPONSIBILITIES

What/who's rights need to be protected?

- 1) Human
 1. The unborn child
- 2) Mammals
- 3) Insects
- 4) Fish
- 5) All animals

- Basically anything that may be getting a gene drive placed in it, that has a conscious mind, that has feeling (which may be determined by humans) or that may affect anything that has a conscious mind, that has feelings (which may be determined by humans)
- The animals whose gene we change may not be aware of the change or may not have a say in the discussion

Who is responsible for protecting these rights?

- 1) Humans (the parents of the unborn children)
- 2) The United Nations
- 3) Educated scientists
- 4) Governments
- 5) Individual countries
- 6) People whose children would be getting engendered

http://www.bbc.co.uk/ethics/animals/using/biotechnology_1.shtml
<https://www.youtube.com/watch?v=POHPHuzsHbI>
<https://www.pbs.org/newshour/science/gene-editing-religion-scientist>
 Gene editing can now change an entire species — forever - ted talk

Full MLA7 Citations
 "Ethics - Animal Ethics: Biotechnology." *BBC*. BBC, n.d. Web. 24 May 2019.
 <http://www.bbc.co.uk/ethics/animals/using/biotechnology_1.shtml>.
 Joseph, Andrew. "Gene-editing, Religion and One Scientist's Quest to Reconcile the Two." *PBS*. Public Broadcasting Service, 14 Oct. 2016. Web. 24 May 2019.
 Kahn, Jennifer. "Gene Editing Can Now Change an Entire Species -- Forever." *TED*. N.p., n.d. Web. 24 May 2019.
 <https://www.ted.com/talks/jennifer_kahn_gene_editing_can_now_change_an_entire_species_forever?language=en>.
 Nutshell, Kurzgesagt – In a. "Genetic Engineering and Diseases – Gene Drive & Malaria." *YouTube*. YouTube, 21 Sept. 2016. Web. 24 May 2019.
 <<https://www.youtube.com/watch?v=TnzcwTy6cE>>.
 Vox. "The Bold Plan to End Malaria with a Gene Drive." *YouTube*. YouTube, 31 May 2018. Web. 24 May 2019. <<https://www.youtube.com/watch?v=POHPHuzsHbI>>.

- It could be used for bad.
 - Countries may not agree on whether to release a species with a gene drive
 - Depending on the species, and what is being released, it could cause problems that could lead to war.
 - o A fruit fly that goes after ripe fruit not just rotting fruit
 - Could ruin a country's agriculture
 - That country could declare war on another
 - This CRISPR technology is simple enough that anyone smart enough could use it.
 - o Labs around the world
 - o Undergraduates
 - o Even smart high school students
- "CRISPR technology." *Gale Science in Context*, Gale, 2018. *Science in Context*. <http://link.galegroup.com/apps/doc/KPZ1IA516790065/SCIC?u=43riss&sid=SCIC&xid=a7d334de>. Accessed 20 May 2019.