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| **Title** | **GM 360°: Case Studies on Genetically Modified Trees** |
| **Introduction** | This activity allows a unique opportunity for students to conduct case studies that provide subjective arguments on both sides of an issue and gain feedback on creating a balanced argument. Students will present case studies objectively and subjectively, providing arguments both for the modification and against the modification of their chosen species. The class then will provide feedback on their opinions. Given a truly balanced argument, the class opinions should fall somewhere in the middle of the range, and should be roughly equal among the many groups. |
| **Curriculum Alignment** | AP Environmental Science-  Competency Goal 7: The learner will build an understanding of environmental decision making.  Objective 7.02 Analyze cultural and ethical considerations regarding the environment; Environmental worldviews; Sustainable development.  Biology-  Competency Goal 3: The learner will develop an understanding of the continuity of life and the changes of organisms over time.  3.04 Assess the impact of advances in genomics on individuals and society.- Applications of biotechnology. |
| **Learning Outcomes** | At the conclusion of this activity, students will be able to:   * Understand why trees are being genetically modified * Know the specifics of one case study related to GM trees * Present a convincing argument on two different sides at once in an effort to influence environmental decision making * Provide feedback to classmates on their presentation of differing perspectives |
| **Time Required and Location** | * teacher prep time- 20 minutes; make copies, gather materials * 10 minutes- introduction of activity * 30-45 min(optional)- research time in class; this may be done at home depending on availability of Internet at home; availability of time and materials at school * 10-30 min- presentations- allow about 2-3 minutes per presentation- a wide range is given to accommodate the different sizes of groups and classes * 5 min- does not need to be a specific time- students can use the first 5 minutes of the next class, or the last 5 min, or a break during a 90 minute block, to place stickers along the bottom scale of the posters around the room * Extension- 15-45 minutes- see ‘alternate assessments’ section for breakown of options |
| **Materials Needed** | * Copies of handouts * Posterboard for each group * Markers, pens, crayons, rulers, tape, glue, etc to help create posters in class * Computers with Internet and printers; students may wish to print pictures and information for their posters * Stickers to place along bottom of student posters   **TECHNOLOGY RESOURCES:**   * Computer access (optional) for Internet research and printing of information; check student availability for Internet and print resources |
| **Participant Prior Knowledge** | * Students should be familiar with the concept of genetic modification of trees, and understand the general process of how genetic engineering works. * Students should have had experience in class presentations, and, if applicable, peer scoring, earlier in the course. |
| **Activities** | * Students will work in cooperative groups of 2-4 students. Each student group will receive the name of one tree species that has undergone genetic modification. They will conduct additional research (online in class or at home) and create posters outlining their species. * The goal is to give a 360° viewpoint of the species and genetic modifications. They should be able to find statistics and research that supports and rejects the genetic modification of trees in general, and specifically that species and the purpose for which it has been modified. * Students will receive the handout entitled “GM: 360°- You Be the Judge” and will be able to follow directions. * Students will complete research either at home or during class to find out the necessary information to complete their posters. * Students will present their posters:   + They will present the objective background information   + One group member will present an argument on why this tree should be genetically modified   + A different group member will present an argument on why this tree should NOT be genetically modified * When complete, hang the posters around the room. Students will have a small amount of time to place a sticker along the 1-10 scale at the bottom of each poster based on where they stand with regard to modification of the species. 1= this should never be modified for any reason; 10= modification would be great for this species!   + *Optiona*l- students can be assigned a specific number for their sticker. This would allow students to look at any individual class member and see if there are trends with their ‘voting’ practices. * *Possible extension listed under “Modifications.”* |
| **Assessment** | * scoring guidelines attached as handout * options:   + teacher-scored   + peer-scored (I usually have approximately 6-8 students score each presentation- randomly passed out- and average the scores). |
| **Critical Vocabulary** | * Genetically modified organism (GMO)- organism whose genetic makeup has been modified by genetic engineering * Genetic engineering- insertion of an alien gene into an organism to give it a beneficial genetic trait * There are several other vocabulary terms that may be needed- depending on the tree species chosen and the research paths used. Check out an environmental science textbook or online dictionary for more specific terms.   + Recommended: Miller’s *Living in the Environment*   + Recommended: [www.dictionary.com](http://www.dictionary.com) |
| **Modifications** | * For diverse classrooms:   + Recommended to have more in class time and teacher guidance.   + I do not suggest peer scoring as students do not often know the diverse needs and learning styles of all other students. * For advanced students:   + *Extension option:*      - When students have finished their presentations and placed their stickers on the posters, have each group look at a poster and determine what could have caused the class opinion to not be even. Students would need to look at a poster other than their own.     - Students can also look at an individual person and analyze trends in opinions. Does this person seem to favor one type of modification over another? Could you predict their general opinion with regard to GM trees?   CONNECT: Pre-select 3-5 students to document voting trends. Compare to a set of their surveys from “Social Perception of Biofuels” lesson. See if the class can match up and find correlations between opinions of biofuels and GM trees. |
| **Alternative Assessments** | * The ‘balanced and fair argument’ component of the scoring guidelines for the presentations can be taken from the 1-10 scoring from the class.   + If the average score is a 5, the students get a 10 for this component.   + For every .5 point deviation from a score of 5, the students would lose one point from their total score for this component. (this can be altered) * Extension options:   + Students analyze a particular species and class opinions related to its modification. They can then present why they feel the poster was perceived as it was by the class.   + Students can analyze trends and turn in or present analysis of an individual’s voting. Individuals should be randomly assigned but should not include anyone from that group. Numbers should also be randomly assigned (not alphabetical, by group, etc.- no one should know who they are analyzing to avoid subjectivity). |
| **References** | * The Institute of Forest Biotechnology- [www.forestbiotech.org](http://www.forestbiotech.org) * NCSU Forest Biotechnology- <http://cnr.ncsu.edu/fer/forgen/index.html> * ArborGen- <http://www.arborgen.com/> * USDA- APHIS- <http://www.aphis.usda.gov/> * Sierra Club- <http://www.sierraclub.org/biotech/trees.asp> * GM Tree Watch- <http://gmtreewatch.org> * There are MANY news articles out there regarding several GM tree species. I did not include news articles as they may become outdated over time. An internet search using keywords such as “genetically modified,” “GM tree,” “GMO tree,” or genetic engineer tree” may yield appropriate search results. Check for articles by Scientific American, Discovery, and New York Times, as well as many press releases and scientific papers published by government, nonprofit, and special interest organizations. I have only included some informational pages above; not actual press releases or news articles. |
| **Supplemental Information** | * Keep in mind the time and materials constraints of students. This activity can also be adapted to fit onto bulletin board paper (available at most schools somewhere in the front office) or on a series of sheets of regular 8.5 x 11 inch computer paper. Additionally, this can be modified to use technology by creating PowerPoint slides to put together in a large slideshow presentation. * Handouts and additional documents:   + Handout for students   + Presentation Scoring Guidelines |
| **Comments** | * This can be adapted to include many different tree species. The ones listed on the handout are not the only trees that have been genetically modified. * This can also be expanded to include other types of genetic modifications. This project was designed specifically with trees in mind- but this can also be used for genetically modified crops or other species. * The practice of being able to approach an argument from both sides can prove important in persuasive essay writing. You may want to work with a 10th grade English teacher if you teach many sophomores for techniques to share with the students. |
| **Author Info** | Heather Earp teaches at West Johnston High School in Benson (Johnston County Schools), where she has been a member of the Science Department since 2003. She has taught numerous science courses including Biology, Honors Biology, Honors Anatomy and Physiology, Earth/ Environmental Science, Environmental Science, Honors Environmental Science, and Advanced Placement Environmental Science. She is a graduate of East Carolina University, where she was a NC Teaching Fellow, and holds a BS degree in Science Education with a concentration in Biology. She holds AP Certification in Environmental Science and K-12 AIG Certification. She has served as a College Board reader for the AP Environmental Science exam. This lesson was developed as part of the Kenan Fellows program through NC State University; Heather is studying Sustainable Forestry and the Use of Botech Trees for Sustainability and Bioenergy. |

**GM: 360°- You Be the Judge**

Genetically modified, or GM, trees have emerged as a key group of organisms undergoing genetic engineering. Modified for a wide range of purposes, trees are being altered at the genetic level to make them resistant to tree diseases, grow faster, and process more efficiently, among other reasons.

For this activity, you will be providing a balanced view of a specific species. In addition to background information, you will also research statistics that both support and reject the modification of your designated species. You will create a poster outlining the key points of your case, and present both viewpoints to the class.

Select your species from the list below:

1. Aspen
2. American Chestnut
3. Chinese White Poplar
4. Fraser Fir
5. Papaya
6. Silver Birch
7. Apple
8. Eucalyptus
9. Sweet Gum
10. Cherry
11. Norway Spruce
12. Scots Pine

**Information needed:**

Name of species:

Native location:

What about the species is being modified:

Why this species is being modified:

Stage of modification process:

Key groups/ individuals/ countries involved with modification of this species:

Information about population size, distribution, population declines, etc:

Information and statistics that support modification of this and other tree species

Information and statistics that reject modification of this and other tree species

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| 4 | |

Presentation of Material:

Create a poster (outline to the left) with the following information:

1. Basic information🡪 name, locations, modifications, reasons, stage of process, and population information; should also include at least two pictures of the tree species
2. “Why to modify” statistics and information
3. “Why NOT to modify” statistics and information
4. Create a scale of 1-10 across the bottom of the poster to be used by the class following presentations

**SOURCES SHOULD BE LISTED ON BACK OF POSTER IN MLA FORMAT!!!!GM-360°**

***Group Presentations Scoring Guidelines*** SPECIES: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Identifies basic information about the tree (both on the poster and in the presentation): **30**

Name of species: 0- No 2- Yes

Native location: 0- No 1- Somewhat 3- Yes

What about the species is being modified: 0- No 1 2 3 4 5- Contains all Info

Why this species is being modified: 0- No 1 2 3 4 5- Contains all Info

Stage of modification process: 0- No 1 2 3 4 5- Contains all Info

Key groups/ individuals/ countries involved: 0- No 1 2 3 4 5- Contains all Info

Population Statistics: 0- No 1 2 3 4 5- Contains all Info

Total: points

Comments:

Argument for why the species should be genetically modified: **30**

Includes convincing statistics 0- None 2 4 6 8 10- Excellent

Relevancy of statistics 0- None 1 2 3 4 5- Excellent

Convincing argument 0- None 2 4 6 8 10- Excellent

Reliable sources of information 0- No 1 2 3 4 5- Excellent

Total: points

Comments:

Argument for why the species should NOT be genetically modified: **30**

Includes convincing statistics 0- None 2 4 6 8 10- Excellent

Relevancy of statistics 0- None 1 2 3 4 5- Excellent

Convincing argument 0- None 2 4 6 8 10- Excellent

Reliable sources of information 0- No 1 2 3 4 5- Excellent

Total: points

Comments:

Balance of Argument: **10**

Argument is fair, accurate, and balanced 0- No 2 4 6 8 10- Excellent

TOTAL POINTS: \_\_\_\_\_\_\_\_\_\_

Overall comments: