Showing Evidence Unit Plan

Title: What's in Your Genes?

Description: Students analyze a controversial biotechnology application and support its free use, limited use, or disuse. They use the *Showing Evidence Tool* to organize their argument, and then conduct a simulation where they write legislation and persuade classmates to accept their views.

At a Glance

Grade Level: 9-12

Subject sort (for Web site index): Science

Subject: Biology

Topics: Biotechnology

Higher-Order Thinking Skills: Argumentation, Evaluation, Experimental Inquiry

Key Learnings: DNA, Fertilization, DNA Fingerprints, Molecular Genetics, Genetic Engineering, Gel Electrophoresis, Scientific Research

Time Needed: Five weeks—four periods per week (three 50-minute periods and a 90-minute period)

Background: Arizona, United States

Unit Summary

Students use their knowledge of biotechnology applications to influence legislation for or against its usage. They study the general concepts of molecular genetics and the technique of developing and analyzing deoxyribonucleic acid (DNA) fingerprints through the use of gel electrophoresis. Next, students view the motion picture *Gattaca*, to see the effects of biotechnology on society and then conduct more research into possible biotechnology applications. The culminating activities include using the *Showing Evidence Tool* to develop an argument supporting the use, use with limitations, or disuse of various biotechnology applications within the United States. Finally, in the simulation, students work in groups to develop several "bills" and attempt to persuade a panel of legislators to approve their recommendations.

Curriculum-Framing Questions

- **Essential Question**
  Just because we can, should we?
- **Unit Questions**
  What is the social responsibility of acquiring scientific knowledge?
  What is the impact of biological discoveries and technological advances on society and on other living things?
- **Content Questions**
  In what ways is biotechnology being used today?
  How do you produce and analyze a DNA fingerprint using gel electrophoresis?
  How can the components and structure of a DNA molecule be identified?

Assessment Processes

View how a variety of student-centered assessments are used in the What's in Your Genes? Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, products; and reflect on learning throughout the learning cycle.

Instructional Procedures

Introduce the Unit

Begin the unit by writing the Essential Question, *Just because we can, should we?* on the board for the entire class to read. Present the idea that for every medical science breakthrough, ethical questions are raised. Inform students that they will be using a science journal to write notes, make observations, and respond to questions throughout the unit. Have students list their ideas about the Essential Question in their science journals. Next, pose the Unit Questions: *What is the social responsibility of acquiring scientific knowledge?* and, *What is the impact of biological discoveries and technological advances on society and on other living things?* Have students record their initial thoughts in their journals. Next, pair up students and have them share their ideas with their partner. Follow up with a class discussion and record students' thoughts on chart paper.

Learning Key Concepts: Lab Investigations

Review the structure of DNA and how DNA replication occurs. Have students conduct investigations of DNA and gel electrophoresis in a lab setting.

Investigate DNA

Students investigate deoxyribonucleic acid (DNA) extraction using kiwi fruit. Guide them through the Kiwi Lab*. This activity allows students to visually spool the DNA from thousands of cells. Discuss what is happening to the kiwi throughout each step of the lab. Link students' prior knowledge of cells to this unit.

Review the structure of ribonucleic acid (RNA) and how protein synthesis occurs within cells. Demonstrate protein synthesis using models or show a video illustrating this to your students. Guide students as they decode a strand of DNA to a protein.

Ask students to decode at least five phrases in the decoding activity. Provide an example that reminds students of the process of creating an mRNA (messenger RNA) strand from the DNA strand, then creating tRNA (transfer RNA) anticodons from the mRNA codons. Print the two decoding activity handouts on different colored paper so that students sitting next to each other will have different phrases to decode. Then have the students solve the codes on a separate piece of paper showing the DNA strand, mRNA strand, tRNAs, and the decoded phrase.

Examine Gel Electrophoresis

Guide the students through the Dye Gel Electrophoresis Lab* during an extended lab period. Discuss proper protocol involved in the use of gel electrophoresis. Ask students to write their thoughts in their science journals about the following questions: *How can the components and structure of a DNA molecule be identified?* and, *How do you produce and analyze a DNA fingerprint using gel electrophoresis?* While the gels are running, review the students' responses to the questions and the

main concepts of the lab.

View the Human Genome video called *The Secrets of Our Lives,* and Time-Line CD, available from The Human Genome Project Kit*. Summarize all of the important events. Next, guide students through the Who's the Daddy? (Whale Pod) Lab* during an extended lab period. While the gels are running, ask the students to answer the questions in the student guide and provide an example of how to analyze the gels to determine the father. Assess the students' understanding of the main concepts of the unit through a written quiz.

After completing the lab activities, lead a discussion about applications of gel electrophoresis and other forms of biotechnology used today. Investigate real world applications of biotechnology further by viewing the movie *Gattaca*. Review the requirements of the *Gattaca* essay with students before viewing the movie. Discuss the essay rubric and answer any questions from the class. Hold a discussion after the movie about the possible effects of biotechnology on society.

Research and Determine a Position on the Use of Biotechnology

Let students know they will be researching and building an argument about uses of biotechnology. Cut the issue cards in fourths so that you have one card per topic. Give each group a card and instruct them to find resources that will provide pros and cons on the use of that form of biotechnology. Discuss what makes a resource valid and reliable. Ask students to collect and record information (minimum of 10 per student) on their issue, using the format below:

- Bibliographic information
- One-sentence summary of information
- Quote of factual information that would help form a claim on the issue

Now have students evaluate their researched information and draw some conclusions. Direct the students to construct a claim as to whether the biotechnology application they are studying should be freely used, used with limitations, or be banned from use. Have students discuss the research they found and pick the ten best pieces of evidence to support their claim.

While students work in groups and discuss their research, observe conversations and use the evaluative thinking checklist to assess their evaluative thinking skills. Use this checklist throughout the learning cycle whenever students are evaluating information and engaging in group discussions and activities.

Use the Tool

Give students the tool guidelines. Introduce students to the *Showing Evidence Tool* by exploring the Try Out the Tool [link to demonstration space] demonstration space together. Discuss the sample case together or create a sample project and show students how to add, describe, and rate evidence and claims.

Hold a discussion around the idea of reliable evidence. Have students ask themselves the following questions when rating the reliability of an evidence source: *Is the source biased? Is the information current? Is the author an authority on the subject? Is the author expressing fact or opinion?* Distribute the argumentation rubric and explain to students that they should use this as a guide as they work with *Showing Evidence*.

Before proceeding with the next activity, click here to set up the What's in Your Genes? project in your workspace. Put students in teams and have them log into

their team space. Ask students to create a claim in the workspace and add at least ten pieces of evidence from their research. Use the Comments feature to give feedback, redirect effort, suggest new avenues of study, or ask for clarification about a team's thinking.

After the students have finished putting their information into *Showing Evidence*, have them review the case of another group that researched the same issue. Peer review groups read and evaluate the claims of the group assigned to them and make constructive comments and corrections where needed to the claims and evidence using the argumentation rubric as a guide.

Examine the Showing Evidence Activity

The *Showing Evidence* space below represents one team's investigation in this project. The case you see is functional. You can double-click on the evidence and comments to read the team's descriptions.
[insert live tool view here—see file management spreadsheet]

Lobby Your Position

Set up the scenario: Step into the future, the year is 2010…The entire Human Genome Project was completed in 2003, and biotechnology is advancing faster than ever before. Legislation is going before Congress and the House of Representatives to determine to what extent various forms of biotechnology will be used within the United States. You have been selected to make recommendations about these biotechnology applications. You will submit a bill to try persuade "legislators" to freely use, disuse, or put limitations on the use of biotechnology on our lives. Your classmates will act as the legislators in this simulation and vote to either approve or reject your recommendations.

Have teams who peer reviewed each other work together to draft a bill by filling in the bill template. The contents of the bill should include:

- The position your bill supports
- Why the bill is needed
- The actions to be taken
- Key definitions
- Funding source (if applicable)

Distribute the bill rubric and go over with students before they begin drafting their bill. Have students use the evidence they collected while using *Showing Evidence* to back up their bill's recommendations during the presentation.

Allow each group ten minutes to present their bill to the class. Have the group read the bill aloud and then field questions. Conclude the presentations by having the class vote on whether to approve each team's bill. See an example of one team's bill.

After each presentation, have students write a short summary in their science journals explaining:

- The key points of the bill
- Suggested changes (if applicable)
- Why they would recommend this bill for approval (or rejection)

Conduct a class discussion on the Essential Question again. Students should have more insight into what causes scientists to explore new solutions to problems and the ethical questions that sometimes arise from the new solutions.

Prerequisite Skills

- A unit on cells should be studied prior to beginning this unit.

Differentiated Instruction

Resource Student

- Afford students extra time for study
- Reduce amount of evidence required
- Pre-select research materials
- Provide support from resource specialists

Gifted Student

- Allow students to explore multiple controversial biotechnological applications

English Language Learner

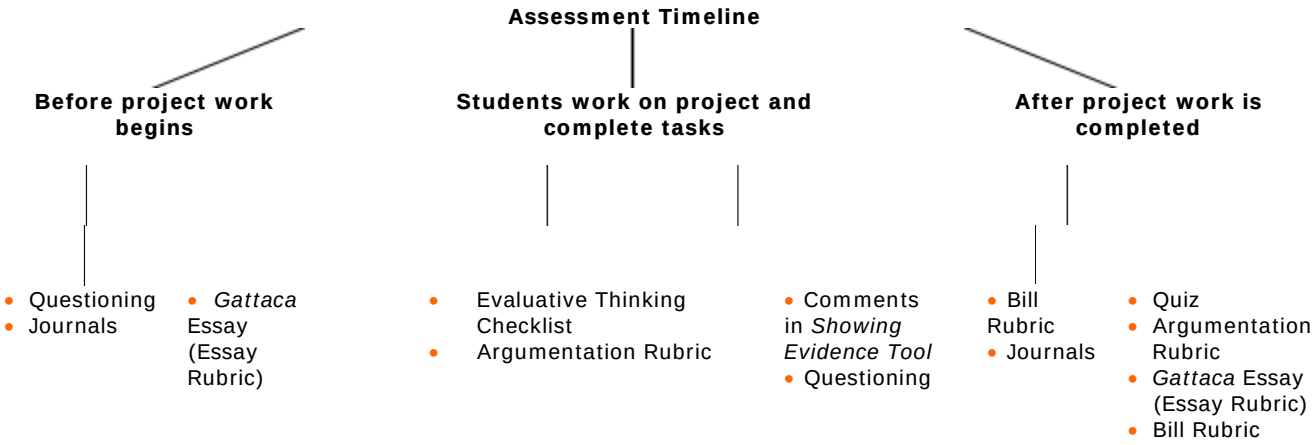
- Encourage support from common language speakers with greater English proficiency
- Allow students to present their bill in dual languages
- Use biology tutorials* offered in Spanish.

Credits

Lynne Coté is a high school biology teacher in Tucson, Arizona. She participated in the Intel® Teach Program, which resulted in this idea for a classroom project. A team of teachers expanded the plan into the example you see here.

THINGS YOU NEED (highlight box)

Assessment Plan



Questioning is used throughout the unit to promote higher-order thinking and assess student understanding. A quiz is used to assess general knowledge of molecular genetics and students' understanding of the lab investigations. Other artifacts of student learning include the *Gattaca* essay, the use of the *Showing Evidence Tool* to

support a claim, and the presentation of a bill. The essay rubric is used within the *Gattaca* essay document to assess essays. The argumentation rubric and bill rubric provide a framework for assessing student learning and guide students throughout completion of the projects. Also, conducting periodic check-ups on students' science journals is a way to keep informed about the progress of students and any difficulties they are having. The evaluative thinking checklist is used throughout the learning process to observe and assess students' higher-order thinking.

Targeted Content Standards and Benchmarks

Arizona Content Standards/Benchmarks:

High School Science Standards

Strands 1:

- Evaluate scientific information for relevance to a given problem.
- Evaluate whether investigational data support or do not support the proposed hypothesis.
- Critique reports of scientific studies (e.g., published papers, student reports).
- Support conclusions with logical scientific arguments.

Strand 2:

- Describe how human curiosity and needs have influenced science, impacting the quality of life worldwide.
- Analyze how specific changes in science have affected society.

Strand 3:

- Recognize the importance of basing arguments on a thorough understanding of the core concepts and principles of science and technology.
- Support a position on a science or technology issue.

Strand 4:

- Analyze the relationships among nucleic acids (DNA, RNA), genes, and chromosomes.
- Explain how genotypic variation occurs and results in phenotypic diversity.
- Describe how meiosis and fertilization maintain genetic variation.

Student Objectives

Students will be able to:

- Analyze information and determine the validity/reliability of the research and source
- Weigh evidence to determine the situation that will be best for the entire population
- Understand the value of being informed on issues
- Use prior knowledge of molecular genetics to interpret research on biotechnology issues

Materials and Resources:

Printed Materials

Magazine Articles:

- (April 11, 2003). Building on the DNA revolution, *Science.*
  Several articles discussing the completion of the Human Genome Project

- (April 24, 2003). DNA 50th anniversary: Double helix at 50. *Nature*.
  Several articles discussing the completion of the Human Genome Project

Supplies

Kiwi DNA Lab:

- Ziplock bags (1 per student pair)
- Strainer or funnel (1 per 10 students)
- Jar or beaker that fits strainer or funnel (1 per 10 students)
- Cheese cloth (cut to cover the funnel)
- Ice water bath (a large mixing bowl works well) (1 per 4-6 students)
- Extraction solution (1 tube of 20 ml. per student pair)
- Kiwifruit (cut into 12 pieces, each student pair needs 6 pieces)
- Cold 95% ethanol or isopropanol (3-4 ml. per student)
- Small test tubes (1 per student)

Dye Gel Electrophoresis Lab:

- 1 x TBE
- Agarose
- Various dye mixtures: Methyl Orange, Bromophenol Blue, Xylene Cyanol, Pyronin Y, Safranin O, Unknown (1 each per group)
- Practice loading dye (above)

Equipment Needed:

- Micropipets and tips to load dye samples (6 per group)
- Small microcentrifuge tubes (0.5 ml. or 0.65 ml. size) (6 per group)
- Electrophoresis units and power supplies (1 per group)
- 1 x TBE for electrophoresis units
- Microwave oven
- Hot water bath for keeping agarose liquified

Who's Your Daddy? Lab:

- DNA from Mother (#1), Luna (#2), male whale A (#3), male whale B (#4) (1 per group)
- Agarose
- Tris-acetate/EDTA solution (TAE)
- Micropipette/tips (4 per group)
- Electrophoresis apparatus (1 per group)
- Methyl blue stain
- Light box (1 per group)

Internet Resources

- The Human Genome Project Kit
  www.nhgri.nih.gov/educationkit*
  Includes a video, multimedia CD-ROM, and tips for using the kit in your classroom
- DNA: Heredity & Beyond
  http://library.thinkquest.org/20830/main.htm*
  A 1998 ThinkQuest which not only gives background information regarding DNA, scientist, and related scientific discovers but also discusses ethical issues surrounding the manipulation of DNA
  - Genetic Disorder Information on the Web
    www.ornl.gov/TechResources/Human_Genome/posters/chromosome/diseaseindex.html*
    Database linking to genetic disorders found on each individual chromosome
  - Chromosome Viewer
    www.ornl.gov/TechResources/Human_Genome/posters/chromosome/chooser.html*
    Visual chromosome map of all 23 chromosome types with links to genetic diseases/disorders found on each individual chromosome
  - Gene Testing
    www.ornl.gov/TechResources/Human_Genome/medicine/genetest.html*
    Includes a description of gene testing along with pros and cons
  - Genetics in the Courtroom
    www.ornl.gov/TechResources/Human_Genome/courts/courts.html*
    Background and implications of using genetics in the courtroom
  - Ethical, Legal, Social, Implications of Human Genome Project
    www.kumc.edu/gec/prof/geneelsi.html*
    Links to several sites that involve controversial biotechnology issues and usages
  - Biotech Program (University of Arizona)
    http://biotech.biology.arizona.edu/labs/labs.html*

    Labs used in unit: Kiwi DNA Extraction, Agarose Gel Electrophoresis with Biological Dyes, DNA Fingerprinting: Whale Pod DNA
  - Biology Project (University of Arizona)
    www.biology.arizona.edu*
    Tutorials in both English and Spanish

Other Resources

- Niccol, A. (1997).Video or DVD: *Gattaca*. Columbia Pictures/Jersey Films.

Technology – Hardware

- Computer with Internet to access the *Showing Evidence Tool*
- Projection system to show students how to use the *Showing Evidence Tool*
- VCR or DVD player to play *Gattaca* and Humane Genome video

Technology – Software

- Word processing software to create biotechnology bills