**The relationship between agriculture and technology**

**Pillar 5 B. Define biotechnology as “a collection of technologies applied to agriculture to solve problems and enhance products”**

(9th – 12th Grade)

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| **Websites:** <http://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=407&author_state=0&grade=9&search_term_lp=natural,%20certified%20organic,%20and%20conventional%20farming%20practice>  **Hands On:** <http://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=407&grade=9&author_state=0&search_term_lp=technology> |

**Biotechnology in Agriculture, Food, and Natural Resources**

**Purpose**

Students will review the purpose and function of cells, practice using punnet squares, and learn about the historical timeline and developments of DNA technology.

**Materials**

**Activity 1:**

* *Cell Analogy Assignment*, 1 per student or group
* Posters, 1 per group
* Miscellaneous art supplies such as markers, construction paper, etc.

**Activity 2:**

* *Animal & Plant Genetics* assignment, 1 per student

**Activity 3:**

* Computers with internet access
* Construction paper
* Scissors, glue, and tape

**Essential Files (maps, charts, pictures, or documents)**

* [Plant and Animal Genetics Assignment](http://naitc-api.usu.edu/media/uploads/2016/02/01/afnr-genetics.pdf" \t "_blank)
* [Cell Analogy Assignment](http://naitc-api.usu.edu/media/uploads/2016/02/01/cell-analogy-assignment.pdf" \t "_blank)

**Vocabulary**

**DNA:** deoxyribonucleic acid, a self-replicating material present in nearly all living organisms as the main constituent of choromosomes

**Biotechnology:** the manipulation of biological processes, especially the genetic manipulation of microorganisms for the production of antibiotics, hormones, etc.

**Cell:** the smallest structural and functional unit of an organism, typically microscopic

**Meiosis:** a type of cell division that results in four daughter cells, each with half the number of chromosomes of the parent cell; used in the production of gametes

**Mitosis:** a type of cell division that results in two daughter cells each having the same number and kind of chromosomes as the parent nucleus

**Punnet square:** a diagram used to predict an outcome of a particular cross or breeding experiment.

**Did you know? (Ag Facts)**

* The benefits of using biotechnology in agriculture include protecting water quality, reducing chemical pesticides, producing healthier food, feeding a hungry world, and helping third world countries by providing more nutritious food.2
* Currently, scientists are utilizing biotechnology to create an edible vaccine for third world countries to help protect them from devastating diseases.2
* Over 70% of the cotton and soybeans grown in the United States are biotech varieties.3

**Background Agricultural Connections**

Prior to this lesson, students should have a basic understanding of DNA, mitosis, meiosis, genetic variability, and punnet squares. Activity 1 and 2 provide a review of these topics, but not an in-depth lesson. For introductory lessons on these topics, see *[DNA: Expressions in Agriculture](http://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=381&author_state=0&search_term_lp=dna" \t "_blank)*, *[Design 'Y'er Genes](http://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=124&author_state=0&search_term_lp=biology" \t "_blank)*, or *[Farming, Food, and Heredity](http://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=330&author_state=0&search_term_lp=biology" \t "_blank)*.

**Interest Approach – Engagement**

1. Ask your students to think about and describe to you how science and agriculture are related. Allow students to use their background knowledge to offer answers. Use guided questions to help them recognize that agriculture includes growing crops and raising animals that provide our food, fiber, and fuel. Basic scientific principles such as genetics, heritability, seed germination, photosynthesis, and plant growth are just a few examples of scientific knowledge that farmers use each day.
2. Ask your students if they can describe how technology is used in science and biology. Allow students to offer their answers.
3. Prior to class review the [Science in Your Shopping Cart](http://www.ars.usda.gov/is/np/shopcart/shopcart.pdf" \t "_blank)booklet. Find a few examples of how biotechnology has been used to improve the production of our food. Describe these examples to your students to help them begin to visualize how biotechnology is used in agriculture to produce the products they use each day. Throughout the lesson, refer back to some of these examples to help students visualize the importance and use of biotechnology in the production of their food.

**Procedures**

**Activity 1: How is a cell like a...?**

1. Review with your class the basic principles of cells. Discuss and point out that every living thing, including both plants and animals are made up of cells and mitosis is the process of cells reproducing.
2. Discuss what a cell organelle is. List the organelles found in a plant and animal cell and describe the function of each.
3. Use the following websites for additional resources:
   * [Cells- Structure and Function](http://www.uic.edu/classes/bios/bios100/lecturesf04am/lect06.htm" \t "_blank)
   * [Biology 4 Kids](http://www.biology4kids.com/files/cell_main.html" \t "_blank)
4. Discuss with your students what an *analogy* is. Give a few examples of analogies to help students understand. For example, you can make an analogy that the golgi apparatus is similar to the post office. The golgi apparatus packages macromolecules such as proteins and lipids as they are synthesized in a cell. A post office distributes and "packages" mail.
5. Pass out the *Cell Analogy Assignment*. This assignment can be completed individually or in groups. Provide the necessary time and supplies for your students to successfully complete the project. Encourage students to be creative.

**Activity 2: What is the outcome?**

1. Review with your class the basic principles of genetics and how a punnet square can be used to calculate the probability of an offspring inheriting a specific trait.
2. Discuss the definitions of the following terms: genotype, phenotype, hybrid, and crossbreeding.
3. Review the process of meiosis and discuss the similarities and differences between mitosis and meiosis.
4. Distribute the *Animal Plant and Genetics*assignment to students.

**Activity 3: Historical Development of Biotechnology**

1. Instruct your students to work in groups of two to help create a class timeline to put around your classroom.
2. Assign each group a list of biotech topics from different eras.
3. Instruct each group to research and print the following information:
   1. Name of each technology or scientist (put in a large font that can be easily seen from a distance)
   2. The year that the technology was first used (again large font)
   3. A picture that would help illustrate each technology or individual
   4. A definition of each technology or description of the scientists and their contribution to biotechnology
4. Once everyone has finished, arrange the entire class timeline in chronological order and attach your information to pieces of construction paper.
5. When the timeline is complete, hang it up around your room.
6. Once the timeline is on the wall, complete the conclusion questions independently. When everyone is finished, discuss your answers as a class.

**Concept Elaboration and Evaluation**

After conducting these activities, review and summarize the following key concepts:

* There are many benefits associated with the application of biotechnology in the production of our food.
* Biotechnology can improve the production of our food, fiber, and fuel.
* It's important to be educated about biotechnology to understand the benefits and potential concerns among consumers.

**Enriching Activities**

* **Careers in Biotechnology:**
  1. Have students research a biotechnology career of their choice and find the following information:
     + Job description
     + Common working conditions
     + Education needed
     + Average income
     + Special skills needed
     + Job availability
     + Describe how this class will help them in this career
     + Unique facts about this career
     + Describe any professional organizations, industry associations, or organized labor connections for this career.
  2. Design a poster or video using [Glogster](http://www.glogster.com/" \l "cooking" \t "_blank) (online poster), [Animoto](https://animoto.com/k/video-slideshow?utm_source=google&utm_medium=cpc&utm_campaign=GENERAL---Animoto-Brand---CON-T1&utm_term=animoto&utm_content=Brand&ef_id=VqZSRQAAAF@c61kR:20160201221628:s" \t "_blank) (interactive video), [Thinglink](https://www.thinglink.com/" \t "_blank) (interactive image), [Moovly](https://www.moovly.com/" \t "_blank) (animated video), or [Storybird](https://storybird.com/" \t "_blank) (interactive online storybook.)
* **GMO Marketing Campaign:**Read the article, *[GMO Debate: The Power of Perception, the Quest for Truth](https://soygrowers.com/wp-content/uploads/2013/01/AmSoyBean_SUMMER2015_web.pdf" \t "_blank)* (Page 20-24). As a class discuss the primary message of the article and how consumers can find good information about GMOs. Instruct students to create an educational marketing campaign to educate consumers about GMOs. Students may use a variety of media types including infographics, posters, video, social media, internet placements, etc.

**Suggested Companion Resources**

* [Bringing Biotechnology to Life](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=282) (Activity)
* [How to Extract DNA from Anything Living](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=516) (Activity)
* [Animal Biotechnology video](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=530) (Multimedia)
* [CRISPR: A Word Processor for Editing the Genome Video](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=471) (Multimedia)
* [Plant and Animal Cell Overview video](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=498) (Multimedia)
* [Biotechnology Ag Mag](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=2) (Booklets & Readers)
* [Science in Your Shopping Cart](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=32) (Booklets & Readers)
* [Garden Genetics: Teaching With Edible Plants](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=718) (Teacher Reference)
* [Agricultural Biotechnology Questions and Answers](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=34) (Website)
* [GMO Answers](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=244) (Website)

**Sources/Credits**

1. Activity 3 was developed and supplied by the United Soybean Board/Soy Checkoff.
2. http://www.soyconnection.com/soybean\_oil/biotech\_facts.php
3. http://www.betterfoods.org/Overview/Facts/Facts.htm