

Biotechnology in Agriculture

STRAWBERRY DNA EXTRACTION (Grades 9 - 12)

INTRODUCTION

Farmers around the world work hard to produce safe, nutritious food to feed both the local and global community while stewarding the land, air and water around them. The world's population continues to grow while the number of farms and available land continues to decrease, so it's important that farmers find ways to grow more while minimizing their land use and environmental impact.



OVERVIEW

Read through the key terms and supplemental resources below to explore some of the tools that farmers and scientists use to efficiently produce safe, nutritious food. Explore the genetic material of a delicious food item through a lab activity. Societal relevance and career connections will also be investigated.

Key terms

Agriculture is the cultivation of land, and breeding of animals and plants, to provide food, fibre, medicinal materials, and other products to sustain and enhance life.

Sustainable development involves using systems and practices that meet the needs of the present without compromising the ability of future generations to meet their own needs. We typically consider sustainability in terms of three pillars: Environmental, Economic and Social. A sustainable system balances ecosystem conservation, financial viability, and the needs of a healthy community.

Sustainable agriculture satisfies human needs for food, clothing and other resources while improving environmental quality, using resources efficiently, reducing waste, maintaining economic viability, and improving quality of life for farmers and communities.

Biotechnology combines knowledge of life and living organisms with modern technology to create new systems, devices, materials, food, etc. that could improve human life and help preserve the environment. Most biotechnologies are associated with agriculture and medicine.

GMO (genetically modified organism) The genetics of virtually all food we eat today have been modified over time, so the term "GMO" could technically apply to all food. When people talk about GMOs, they are often referring to genetically engineered organisms which are created by using biotechnology to make a targeted change in a plant, animal, or microbial gene sequence to achieve a specific result.

Examples of biotechnology in agriculture

- Drought, cold, and pest resistant plants
- Reproductive technologies
- Environmental cleanup
- Improved vaccines
- Transgenic animals
- Improved nutrition
- Reduced food waste
- Genetically Modified Organisms (GMOs)

Supplemental resources

Visit the link to watch a short video on plant breeding and GMOs: <https://www.youtube.com/watch?v=pyo2KBbiLY>

Visit the [snapAG](#) page for more information on these topics:

- Genetics and Farming
- What are GMOs?
- GMO Foods
- GMOs and the Environment
- GMOs Around the World

STRAWBERRY DNA EXTRACTION LAB ACTIVITY

PURPOSE

Many biotechnologies are applied to the DNA of plants. With GMOs, the sequence of a plant's DNA is altered in order to modify or induce a trait. In this activity you will collect and observe the DNA from strawberries.

MATERIALS NEEDED

- 90mL water
- 10mL dish soap
- 1.25mL salt
- 1 strawberry (frozen works well)
- 5mL rubbing alcohol chilled in the freezer for at least an hour
- 2 small glass containers
- stir stick
- zipper sandwich bag
- strainer
- eye dropper or bamboo skewer

PROCEDURE

1. Combine water, dish soap and salt in a small glass container (a bowl or measuring cup would work as well). Mix well.
2. Place the strawberry and the dish soap mixture in the zipper sandwich bag. Removing as much air as possible, carefully seal the bag. Rinse the glass container; you will use this again.
3. Manually mash the strawberry with your fingers through the zipper sandwich bag for about 5 minutes or until no large pieces remain.
4. Set the strainer on the glass container. Carefully pour the strawberry mixture through the strainer to separate the liquid and solid portions. Gently press the solids caught in the strainer to remove as much liquid as possible. Discard the solids.
5. Transfer the liquid to the second glass container (a transparent measuring cup or small drinking glass would work well). Add 5mL of chilled rubbing alcohol.
6. View the glass container at eye level. Make note of your observations.
7. Using the eye dropper or bamboo skewer, remove the white filmy layer. It is safe to handle if you want to feel it.
8. Thoroughly wash and dry all the reusable equipment. Properly dispose of the consumable materials.

DISCUSSION QUESTIONS

1. Why did we mash the strawberries?
2. Why did we use dish soap?
3. What does lysis mean?
4. Why did we use salt?
5. Why did we use alcohol? Why was the alcohol chilled?
6. What did you see when you observed the test tube at eye level?

ANSWERS

1. Breaking up the cellulose in the plant cell walls allows the detergent solution to come in contact with the lipid cell membrane.
2. Dish soap detergents break up lipids. This is why soap works on dirty dishes: it breaks up the cell membranes to allow the DNA to escape from the nucleus.
3. Lysing a cell means cutting it open. We used dish soap to lyse or cut open the cells. The DNA was able to leave the lysed cell but wasn't immediately visible because it is tightly packed and very, very small.
4. Salt neutralizes the negatively charged phosphate group on the DNA backbone so the DNA molecules can come together instead of repelling each other (makes DNA less soluble in water).
5. Alcohol was used to make the DNA visible. We could see DNA with the naked eye by collecting cells, breaking them open, and condensing the DNA from all the cells together. Think of the DNA molecules as thin white threads: if they were stretched across the room, they would be hard to see, but piled all together on the floor they would be visible. Alcohol made the DNA 'pile together on the floor' (precipitate) or come out of the solution into a mass large enough to see. Chilling the alcohol before mixing it into the cell solution improved its ability to cause the DNA to precipitate.
6. If you viewed the glass container at eye level, you should have initially noticed a transparent pink liquid. Adding the chilled alcohol likely caused a cloudy region to form in the centre of the liquid. You may have caused the cloudy region to increase by gently stirring with the bamboo skewer. Finally, you may have been able to pick up the cloudy mass with the skewer. This mass contains the nucleic acids and DNA from the strawberry.

RELEVANCE OF DNA ISOLATION

Isolation of DNA is often the first step of many types of research, forensic or clinical analysis, including:

- DNA profiling
- Cloning
- Disease diagnoses
- DNA sequencing
- GMOs in agriculture or pharmaceuticals
- Environmental testing, biodefense

BIOTECHNOLOGY CAREERS IN AGRICULTURE

Biological Technician - Work with biologists to conduct tests, record observations, and research information in relation to the environment. Carry out experiments to support research. Set up, operate, and maintain laboratory equipment.

Agricultural Technician - Conduct research and perform tests on samples of plants and animals. Determine the yield for a new seed variety by planting and monitoring seeds in a test plot. Perform experiments to determine how to stop the spread of a plant virus. Maintain agricultural facilities and equipment.

Forensic DNA Analyst - Identify, isolate, and even copy small amounts of DNA from biological evidence. Compare DNA strands to those from a known source to determine whether there is a probability of a match. Can place criminals at a crime scene or identify victims.

Plant Scientist - Study crops and develop ways to improve their quality and yield. Control pests and weeds more safely and effectively. Conserve soil and water. Find ways to help feed our growing population.

Clinical Research Associate - Assist in the design, preparation, planning, implementation and review of clinical trials. Ensure research adheres to regulatory and ethical standards.

Animal Scientist - Conduct research and experiments to breed, care for, and develop domestic farm animals. Explore and perform research on animal genetics and crossbred animals; advises farmers on animal care.

To explore more [agriculture careers](#) check out this interactive website: [thinkAG](#)