LEARNING EXPERIENCE TWO

Guiding Question: How can biotechnologies affect biodiversity?

This **Learning Source** provides starting points and information to investigate: • Agricultural biodiversity • Breeding and artificial selection • Biotechnology • Genetically modified organisms • Traditional knowledge	**Build Competencies: Discover biotechnologies** Students Investigate DNA to build understandings of biotechnology and genetic modification and explain possible impacts on agriculture and the food supply. This handout includes activities that support competencies and weblinks to online resources that students can explore.	**Assess** Look for evidence of understanding of the following concepts: • Biodiversity • Selective breeding • Biotechnology • Genetic modification For a formative assessment, have students use a **T-Chart** graphic organizer to create **illustrated definitions** of terms. Use one column for biotechnology terms and the second for terms related to biodiversity. Require students to connect each definition to agriculture. Ask students to work with a partner to compare their definitions and discuss their relevance to farming and food.

Lab Preparation

This learning source provides instructions for two labs that students can complete as an introduction to the role of DNA in biotechnologies. Remind students to think about how understandings of DNA and genetic sciences are connected to applications in agriculture.

Creating DNA: How does an understanding of the genetic structure help build understandings of how biotechnologies work? Students are encouraged to see that the backbone of DNA is made of sugars and phosphates, while the bases are on the inside of the structure. They will learn that Adenine is always paired with Thymine, and Guanine always with Cytosine.

Prepare the following lab supplies:

- Licorice vines (2 per group)
- Toothpicks (20 per group)
- Gummy candy, jellybeans or small marshmallows in four colours (20 per group)

Additional information and discussion questions are provided in the carousel slide for this guiding question in the smart AGRICULTURE section of the LEARN webpage.

Click on the carousel slide to open and explore the following content.

- A discussion of **the challenges for biodiversity**
- How the *Convention for Agricultural Biodiversity* is part of **protecting agricultural biodiversity**

> SCAFFOLD AND DIFFERENTIATE

Encourage students to be creative and identify and use materials of their own choosing to create their DNA models.

Find **Science 9** learning outcomes supported by this learning experience on the following page.

Use this activity to have students focus on the range of biotechnologies that apply to agriculture. Encourage students to identify examples of these biotechnologies, describe how they affect farming and food production and reflect on the role these technologies play in agricultural biodiversity.

After completing activities in this learning experience, have students reflect on the importance of agricultural biodiversity. Why is biodiversity important to livestock farming? What contributions have biotechnologies made to livestock biodiversity?

Extracting DNA: How can DNA be purified from cells? Students extract DNA from strawberries and other fruits or grains to explore the chemical and physical properties of DNA. This activity provides students with the opportunity to isolate DNA.

Students also reinforce their understanding of cell structure and biological macromolecules.

Prepare the following lab supplies:

- Medium sealable plastic bag (i.e., Ziploc) (1 per student)
- Previously frozen strawberries (1 per student)
- Banana or apple (1 segment per student)
- Chickpea or black bean (1 per student)
- DNA extraction buffer (10 mL) pre-mixed for class: 50mL dish soap; 15g NaCl (2 tsp plain salt); 900 mL water
- Paper towels (1 per student)
- Ice cold 90% ethanol or isopropyl alcohol
- Test tube or plastic champagne flute (1 per student)
- Funnel (optional)
- Glass stirring rod or wooden bbq skewer (1 per student)

Additional Research or Background Sources

Consult teacher or student background sources such as the examples that follow to further explore, enrich or expand activities for this guiding question. Student research sources are also provided in **Build Competencies** handouts.

The Alberta Biodiversity Monitoring Institute provides information on biodiversity in Alberta at **https://www.abmi.ca/home.html**.

Health Canada provides some information about biotechnologies and genetically modified foods at **www.canada.ca/en/health-canada/services/food-nutrition/genetically-modified-foods-other-novel-foods/factsheets-frequently-asked-questions/part-1-regulation-novel-foods.html**.

The Your Genome website provides a webpage focused on animals and plants, with some articles that focus on selective breeding and GMOs, at **https://www.yourgenome.org/topic/animals-and-plants**.

Health Canada commissioned a R*eport on Consumer Views of Genetically Modified Foods* in 2016. This report may provide some background information and can be accessed at **http://epe.lac-bac.gc.ca/100/200/301/pwgsc-tpsgc/por-ef/health/2016/042-15-e/report.pdf**.

Excerpts from this report, such as the discussion provided in the sidebar on this page, provides a context that can be discussed with students and used to make connections between evidence-based information and misinformation, focusing on misconceptions about GMOs.

Health Canada provides some information about biotechnologies and genetically modified foods at **www.canada.ca/en/health-canada/services/food-nutrition/genetically-modified-foods-other-novel-foods/factsheets-frequently-asked-questions/part-1-regulation-novel-foods.html**.

The Your Genome website provides a webpage focused on animals and plants, with some articles that focus on selective breeding and GMOs, at **https://www.yourgenome.org/topic/animals-and-plants**.

Cootie Genetics from the University of Arizona Biotech Project is a hands-on inquiry-based activity that enables students to learn Mendelian laws of inheritance. The activity begins with two true breeding Cooties of the same species that exhibit five observable trait differences. Students observe the retention or loss of traits among the first-generation heterozygotes, hypothesize what happened to these traits and design an experiment to test their hypotheses by mating these first-generation Cooties. With the second generation, students will see that the random selection of trait factors trait factors will create new Cooties.

This lab teaches students how recessive and dominate traits combine in the Cootie offspring, Mendal's principles of segregation and independent assortment, and provides the tools necessary to construct Punnett squares. Resources for this program can be accessed at **http://biotech.bio5.org/cooties**. Find an article that describes this program from *The American Biology Teacher* at **http://biotech.bio5.org/sites/default/files/pdf/ABT7603_March_Galloway%20color.pdf**.

> EXTEND LEARNING

Challenge students to create a **photo poster** that represents applications of DNA in agriculture and food production.

Start by sharing and reviewing the information provided by Agriculture and Agri-Food Canada on day-to-day applications of genomics at **www.inspection.gc.ca/about-the-cfia/science/our-research-and-publications/science-fact-sheet-using-genomics-tools/eng/1536852905722/1536852934789**. Support students in finding connections between genomics and food production. Discuss the examples provided.

Have students create a photo poster that explains the applications of DNA barcoding to farming. Find examples of these types of posters on DNA barcoding on the CurioCity website at **http://explorecuriocity.org/Explore/ArticleId/4307/dna-barcoding-at-the-toronto-zoo.aspx**.

Findings from the focus groups and results of the survey indicate that consumers' basic understanding of food science and technology is low. This is not surprising given a number of factors, including the shift from a more agrarian to more industrialized and urbanized society. Consumers believe that genetic modification is a process which does or could include injecting fruits, vegetables, animals and food products with potentially hazardous materials such as hormones, antibiotics, steroids or other product enhancers which then fundamentally changes the nature and composition of the product. The term "Franken-food" came up in almost every focus group in the context of discussions about GM foods, although many consumers clearly know very little about the actual science of genetic modification.

It is clear that, for quite some time, there has been and continues to be an information void on this issue which has been rather successfully filled by the anti-GMO view. It was evident from the focus group discussions that the general population has a relatively low level of scientific literacy, and this finding was also confirmed in the quantitative survey. Further, there is very little specific knowledge of GM foods, genetic engineering, biotechnology or even older practices such as selective breeding. There also appeared to be minimal understanding of innovation in farming practices or the challenges that farmers and agribusiness face in producing higher volumes at reasonable prices, meeting changing consumer preferences, and getting food products to market quickly while also being increasingly attendant to sustainable agricultural techniques and practices.

Learning Experience Two: Learning Outcomes and Competency Map

project AGRICULTURE Activity	GRADE 9 SCIENCE	SCIENCE 10	SCIENCE 14
	CONCEPTUAL KNOWLEDGE	**CONCEPTUAL KNOWLEDGE**	**CONCEPTUAL KNOWLEDGE**
LEARNING SOURCE How can biotechnologies affect biodiversity?	**Unit A Biological Diversity** 3. Describe, in general terms, the role of genetic materials in the continuity and variation of species characteristics; and investigate and interpret related technologies • Describe, in general terms, the role and relationship of chromosomes, genes and DNA • Compare sexual and asexual reproduction, in terms of the advantages and disadvantages (e.g., recognize that asexual reproduction provides an efficient means of transmitting characteristics and that sexual reproduction provides an opportunity for recombination of characteristics) • Distinguish between, and identify examples of, natural and artificial selection (e.g., evolution of beak shapes in birds, development of high milk production in dairy cows) • Describe, in simple terms, some genetic technologies (e.g., cloning and genetic engineering); and identify questions and issues related to their application 4. Identify impacts of human action on species survival and variation within species, and analyze related issues for personal and public decision making • Investigate and describe the use of biotechnology in environmental, agricultural or forest management; and identify potential impacts and issues (e.g., investigate issues related to the development of patented crop varieties and varieties that require extensive chemical treatments; identify issues related to selective breeding in game farming and in the rearing of fish stocks) Work collaboratively in carrying out investigations and in generating and evaluating ideas (e.g., choose a variety of strategies, such as active listening, paraphrasing and questioning, in order to understand other points of view; accept various roles within a group, including that of leader)		
	PROCEDURAL KNOWLEDGE	**PROCEDURAL KNOWLEDGE**	**PROCEDURAL KNOWLEDGE**
BUILD COMPETENCIES Discover biotechnologies	**Unit A Biological Diversity** Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Observe and record data, and prepare simple line drawings (e.g., compare two related plants by measuring, describing and drawing them) • Estimate measurements (e.g., estimate the population of a given plant species within a study plot) • Research information related to a given issue (e.g., conduct an electronic search for information on factors that affect the reproduction and survival of wood frogs) Analyze qualitative and quantitative data, and develop and assess possible explanations • Identify strengths and weaknesses of different ways of displaying data (e.g., compare different ways of recording and displaying data on plant variation in a study plot) • Interpret patterns and trends in data, and infer and explain relationships among the variables (e.g., interpret data on changing animal populations, and infer possible causes) • Apply given criteria for evaluating evidence and sources of information (e.g., evaluate sources based on their currency, credibility and the extent to which claims are supported by data) Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means (e.g., illustrate and compare methods of reproduction in sample organisms studied)		