Instructional Scenario
Investigating Plant Growth, Plant Development, or Plant Modification

Course/Duty Area: Biological Applications in Agriculture/Understanding the Study of Living Things

Scenario:
Your agriculture class has been working in the greenhouse on sexual and asexual propagation. The plants are in various stages of growth and will be ready for the annual spring plant sale in April. While working in the greenhouse, your teacher provides information about the FFA Agriscience Fair and indicates participation in the Agriscience Fair is an opportunity to showcase your understanding of how biological principles can be used to solve agricultural problems. After extensive class discussion, half of the class wants to investigate plant growth, and the other half of the class wants to investigate plant development.

Your teacher explains both investigations can be performed, however, several aspects of the investigation will need to be considered, such as the scientific principles and experimental procedures you will use. The teacher explains the experiments must follow a scientific process for the investigation. The teacher explains you must collect and analyze data to support the research hypothesis. The following activity will help you foster scientific thinking and problem-solving skills through independent research and experimentation.

Your assignment is to create a dichotomous key to identify and classify the different types of plants in the greenhouse based on their physical characteristics (e.g., leaf shape, flower structure, stem type, growth form). Additionally, you are to formulate a research hypothesis (question or objective) based on plant growth, or plant development, and/or plant modification and how it affects plant growth, plant development, or the value of plants used for food, fiber, or other agricultural products.

You have been instructed to research the Virginia FFA Association's website to review the Agriscience Fair handbook for instructions and details about the Agriscience Fair project components. After reviewing the handbook, you will develop and conduct your experiment. Your findings will be put on display during the spring plant sale. You should plan to be present during the plant sale to answer questions about your project.

Big Questions:

- How does one determine if and how plants have been altered or modified to improve their value or affect their growth or development? If they have been modified, how does one determine if this is positive?
- How do the stages of plant development (e.g., vegetative growth, reproductive growth, maturation, yield, quality, nutritional value, shelf life) affect plants used for food, and/or fiber, and/or other agricultural products?
- How does plant growth affect plants used for food, and/or fiber, and/or other agricultural products?

Focused Questions:

- Plants are made up of what type of units?

- Plants reproduce by using which two methods?
- Plants are made up of what genetic material and genetic code?
- Within a plant's lifetime, plants perform what two tasks?
- What are the three things plants need to perform photosynthesis?
- What are conditions that plants have adapted to (e.g., temperature, water availability, light, soil type)? Explain how plants have evolved to adapt to the various conditions.
- What process assists plants in maintaining a stable environment?
- What do plants do over time that allows them to change?
- How do plants differ from animals in how they are used for food, fiber, and/or agricultural products?
- How are plants modified using traditional breeding and genetic engineering (e.g., improved nutritional content, enhancing the quality of fibers) to improve the value of food and fiber?
- How are plants modified using genetic engineering to improve disease resistance, pest resistance, and provide higher yields?
- What are the benefits of plant modification using genetic engineering (GMOs) to alter a plant's DNA to introduce or modify specific genes?

  Agricultural Strategies:

  - *Biofortification*—enhancing the nutritional content of crops by increasing levels of vitamins, minerals, or other beneficial compounds
  - *Insect Resistance*—introducing genes that make plants resistant to certain insects, reducing the need for pesticides
  - *Herbicide tolerance*—making plants resistant to specific herbicides, allowing for easier weed control
  - *Drought resistance*—developing plants that can tolerate drier conditions
  - *Yield improvement*—creating plants that produce more food or fiber per unit area
  - *Quality enhancement*—modifying traits like taste, texture, or shelf life

  Methods of Genetic Modification:

  - *Gene guns/biolistics*—tiny particles of DNA are shot into plant cells using high-pressure gas
  - *Agrobacterium-mediated transformation*—using a naturally occurring bacterium to transfer genes into plant cells
  - *CRISPR/Cas9*— a gene-editing technology that allows for precise and efficient modification of DNA
  - *Other methods*—Include electroporation, microinjection, and viral vectors

  Benefits of Plant Modification:

  - Increased food security—improved yields and resilience to pests and diseases can lead to more food production
  - Enhanced nutrition—biofortification can address micronutrient deficiencies in populations
  - Reduced environmental impact—herbicide-tolerant and pest-resistant crops can reduce the need for chemical inputs
  - Improved fiber quality—modifications can lead to stronger, softer, or more durable fibers

Project-Based Assessment:

The final project should be a dichotomous key that meets the criteria above. The laboratory report should include all the components outlined in the FFA Agriscience Fair rubric.

Teacher Resources:

- Dichotomous Key – Rangeland U-Idaho
- Making a Dichotomous Key – Rangeland U-Idaho

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