Biotechnology

Cluster Big Idea:

- Advancing life through the contributions made by biotechnology.

Cluster Enduring Understandings:

- Biotechnology is dynamical.
- Biotechnology is a global economic system.
- Human decisions and choices affect the progression of biotechnology.
- Biotechnology serves a multifaceted role to sustain or improve the quality of life.

Cluster Essential Questions:

- What is biotechnology?
- How is biotechnology a global economic system?
- Why is biotechnology considered a dynamic science?
- How is the development of life skills supported by Biotechnology?
- In what ways does biotechnology enhance the quality of life?

Standard Statement: Students will study biotechnology and its relationship to agriculture.

Biotechnology

Performance Element BT.01: Explore biotechnology in the form of an initial inquiry.		
Performance Indicator BT.01.01: Explore and discuss research in biotechnology.		
Basic	**Proficient**	**Advanced**
Discuss the process of research in biotechnology.	Identify the social and economic impacts of biotechnology. Develop reasoning skills needed to discuss ethical issues in biotechnology.	Analyze past trends related to ethical issues in biotechnology, apply this analysis to predict future issues, and describe solutions that could help provide for easier transitions between advances in medicine and agriculture.

Performance Element BT.02: Define and explore biotechnology and its scientific roots.		
Performance Indicator BT.02.01: Define biotechnology as it relates to agriscience.		
Basic	**Proficient**	**Advanced**
Discuss the application of biotechnology.	Formulate and complete assigned biotechnology-related experiments by following specified instructions. Collect, analyze, and submit data from assigned biotechnology-related experiment.	Use previous knowledge and experience to develop a research project in an agriscience-related biotechnology area following the National FFA AgriScience Fair guidelines.
Performance Indicator BT.02.02: Understand the importance of biotechnology to sustaining and improving the quality of life.		
Basic	**Proficient**	**Advanced**
Identify the basic need for biotechnology.	Collect information on current biotechnological advances that improve the quality of life.	Predict future needs that biotechnology may be able to meet and suggest ways to meet those needs. Identify potential problems with future biotechnological needs and offer solutions to these problems. Conduct research into future biotechnological needs and formally document findings and conclusions.

Performance Indicator BT.02.03: Understand and use the principles of scientific research.		
Basic	**Proficient**	**Advanced**
Discuss basic information concerning the scientific method and scientific research. Describe how research is used. Explain why the scientific method is important to research. Identify what is involved in the scientific method. Determine when the scientific method should be applied. Describe how to create and test a hypothesis. Make observations, collect data, and draw conclusions.	Apply the scientific method to solve an assigned problem.	Design and conduct labs that follow the scientific method.
Performance Indicator BT.02.04: Explain the evolution of biotechnology.		
Basic	**Proficient**	**Advanced**
Discuss timelines of important events. Discuss the development of biotechnology and the effects it has had on past, current, and future trends. Discuss natural developments versus man-made developments.	Recreate biotechnology labs that have been conducted throughout history to examine the development of biotechnology and the effects it has had on past, current, and future trends.	

Performance Element BT.03: Identify and analyze the biological and physical characteristics of cells.

Performance Indicator BT.03.01: Understand the importance of cells.

Basic	Proficient	Advanced
Explain that cells assume highly varied forms in different plants, animals, and microorganisms. Explain that the structural variations of cells determine the function each cell performs. Identify the structure and function of the distinct and separate structures (i.e., organelles) within the cell and cell membrane. List how cells work together to perform a variety of chemical functions (e.g., photosynthesis and digestion) necessary for an organism to survive.	Explore, investigate, and find known answers to experiments that require an understanding of the importance of cells. Utilize the microscope to identify different types of cells. Conduct investigations regarding the control of transpiration rates in algae.	Design an experiment or research project, which follows the scientific method, in order to discover an unknown answer or solution to a problem regarding the importance of cells.

Performance Indicator BT.03.02: Define and explain the different types of cells.

Basic	Proficient	Advanced
Describe the difference between prokaryotic and eukaryotic cells. Explain the role of cells in different types of systems (e.g., the nervous system and immune system). Describe cells that perform specialized functions as a part of subsystems (e.g., tissues, organs, and organ systems) in multicellular organisms.	Conduct microscopic identification and propagation of cells. Isolate, maintain, and store pure cultures.	Isolate, propagate, harvest, and characterize bacteria, fungi, yeast, and viruses.

Performance Indicator BT.03.03: Explain cell reproduction.

Basic	Proficient	Advanced
Explain that, during the cell cycle, DNA of the parent cell replicates and the cell divides into two cells, both of which are identical to the parent cell. Explain that meiosis is the production of sex cells and leads to genetic variety. Compare and contrast the process of mitosis with the process of meiosis.	Explain the process of cellular cloning. Explain how cellular division is applied to the field of agriculture.	Find applications of cellular research that will enhance local agriculture, both socially and economically. Develop criteria to regulate future cellular research in order to meet the social and economic needs of society.

Performance Element BT.04: Examine components of genetic transfer and the processes and procedures involved.		
Performance Indicator BT.04.01: Understand DNA sequencing.		
Basic	**Proficient**	**Advanced**
Predict offspring genotypes and phenotypes using Mendel's laws and the Punnett square. Identify and describe transcription and translation. Explore the causes of mutations as well as their costs and benefits and what affects their rate of growth. Explain the tools and techniques used in recombinant DNA technology and how this technology contributes to scientific advances. Demonstrate the separation of proteins by gel electrophoresis in order to understand DNA sequencing.	Isolate, propagate, harvest, and characterize plant and animal cell lines. Conduct investigations regarding the control of transpiration rates in algae.	Express recombinant DNA molecules and detect products using bioassays. Perform and interpret the results of polymerase chain reaction. Perform and interpret the results of a southern or northern blot analysis.

Performance Element BT.05: Identify and examine methods and purposes for creating a genetically modified organism (GMO).

Performance Indicator BT.05.01: Demonstrate the process of gene splicing in plants.

Basic	Proficient	Advanced
Identify and explain procedures related to the creation of a GMO. Apply the technology used to create GMOs to the fields of medicine and agriculture. Analyze future trends in the production of GMOs.	Apply the techniques used to create a GMO to experiments in the laboratory (e.g., gene transfer, cloning, and biolistics). Discuss the ethical issues surrounding the environmental impact and public perception of gene manipulation.	Manipulate genetic material, reproductive processes, and embryological development. Identify and discuss the issues related to GMOs that raise ethical, legal, social, and public policy questions.

Performance Indicator BT.05.02: Demonstrate the process of gene splicing in animals.

Basic	Proficient	Advanced
Identify and explain procedures related to the creation of a GMO. Apply the technology used to create GMOs to the fields of medicine and agriculture. Analyze future trends in the production of GMOs.	Research techniques related to genetic engineering or the creation of a GMO in the field of animal science. Discuss the ethical issues surrounding gene manipulation of or experimentation with living animals, as well as public perception.	Manipulate genetic material, reproductive processes, and embryological development. Create choices that raise ethical, legal, social, and public policy questions.

Performance Element BT.06: Employ knowledge of the components of animal biotechnology processes, procedures, and uses.

Performance Indicator BT.06.01: Describe technology related to advances in the field of animal science.

Basic	Proficient	Advanced
Identify and explain animal reproductive technology. Analyze technology related to animal growth and health.	Explore animal stem cell structure, as well as stem cell research and the uses of stem cells. Replicate the artificial insemination process. Analyze and interpret Web-based reproductive technology models. Create a management plan that reflects the advances in animal health and growth.	Research emergent technology in the field of animal science.

Performance Element BT.07: Employ knowledge of the components of plant biotechnology processes, procedures, and uses.		
Performance Indicator BT.07.01: Describe technology related to advances in the field of plant science.		
Basic	**Proficient**	**Advanced**
Examine the differences between sexual and asexual propagation. Identify plant growth requirements. Examine seed production. Analyze technology related to plant health and growth.	Illustrate sexual and asexual propagation methods. Examine the effectiveness of plants that have been genetically improved or modified. Analyze and interpret Web-based plant-growth technology models. Create a management plan that reflects the advances in plant health and growth.	Research emergent technology in the field of plant science.

Performance Element BT.08: Examine the impact of biotechnology on medical advances.		
Performance Indicator BT.08.01: Describe technology related to advances in the field of medicine.		
Basic	**Proficient**	**Advanced**
Describe the role of the Food and Drug Administration (FDA) in new drug approval. Identify common disease-causing agents. Explain the concept of pharming. Describe how animals and plants can be used to produce drugs.	Determine how animal genetic engineering may contribute to developments in organ transplant. Identify and describe the role of DNA fingerprinting. Identify and describe applications of biotechnology in the field of forensics.	Research emergent technology in the field of medicine.

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Performance Element BT.09: Discuss the ways in which biotechnology benefits the environment.		
Performance Indicator BT.09.01: Describe technology related to advances in the field of environmental science.		
Basic	**Proficient**	**Advanced**
Describe the role of bioremediation in pollution cleanup. Explain how high-yield farming can help or hurt the environment. Discuss the benefits of growing plants that can survive harsh conditions. Identify the benefits of using microbes to clean up pollution. Identify environmental problems that could be solved with biotechnology. Describe how biodiesel fuel benefits the environment.	Analyze the use of biotechnology in the development of crops as a fuel source. Explain the need for alternative fuel sources.	Research emergent technology in the field of environmental science. Research and develop a solution to a regional environmental science issue, using technology related to biotechnology.

Performance Element BT.10: Employ knowledge of the components of biotechnological processes, procedures, and uses in the food industry.		
Performance Indicator BT.10.01: Describe technology related to advances in the field of food science.		
Basic	**Proficient**	**Advanced**
Examine how biotechnology can help preserve food. Describe enzyme production as it relates to the food industry. Examine how biotechnology can be used to increase the nutritional value of food. Identify principles of food safety.	Detect and control the growth of harmful bacteria. Demonstrate principles of food safety through the experimentation of food preservation.	Research emergent technology in the field of food science. Market a potential product that has been created through genetic engineering.

Biotechnology

Performance Element BT.11: Evaluate consumer and ethical views of biotechnology and their impact on the industry.		
Performance Indicator BT.11.01: Examine biotechnology from an ethical standpoint.		
Basic	**Proficient**	**Advanced**
Identify changes in society as a result of biotechnological advances. Explain how biotechnology affects society. Identify current laws related to biotechnology.	Participate in a discussion and debate regarding past, current, and future ethical issues in biotechnology.	Describe the controversy surrounding the patenting of life forms. Identify ethical issues that lack laws or regulations. Examine how ethics may shape the future of biotechnology.
Performance Indicator BT.11.02: Examine consumer concerns related to advances in biotechnology.		
Basic	**Proficient**	**Advanced**
Analyze social and cultural issues related to the introduction of genetically modified organisms (GMOs). Examine arguments against the use of bioengineered food. List the regulatory agencies and current safe guards used to monitor the use of bioengineered organisms.	Explain consumer concerns related to the cloning of animals and humans. Examine arguments against the use of bioengineered food.	Survey current public perception of biotechnology and predict future trends. Develop potential laws, which would follow proper procedures, to regulate future biotechnological advances.