BIOTECHNOLOGY
Agriculture Education

Agriculture

Definition: A dynamic human activity that produces food and fiber from development through growth to the table and beyond.

Rationale: Students understand career opportunities, and the impact of biotechnology on the food, fiber and natural resource systems.

PA Standards		Content	Activity
3.4.4 A	4.4.4 A	Know the basic human, plant and animal needs: • Clothing • Food • Shelter • Space • Water	Developing a Biotechnology Bulletin Board**, BLA #10** Guest Speaker: Agricultural Professional, **BLA #3** Grow different numbers of plants in an area—Which density is optimum?
3.4.4 B		Understand that plant and animal cells are building blocks.	
3.4.4 A 3.1.4 A	4.4.4 B	Know the influence of agriculture biotechnology on: • Basic human, plant and animal needs. • Various cultures.	Create models of plant and animal cells, labeling parts and functions. Bubbling Bread, **BLA #30** Growing a Hydroponic Plant and a Soil Based Plant for Comparison, **BLA #22** Soil Stories, **BLA #28** *(Students will create origin maps for plants and animals.)* *Students can tract a commodity (e.g. bread) back to a field.*
	4.4.4 B	Know examples of agricultural products and their origins. (Wool, cotton, peanuts, mushrooms, etc)	Identify and track the processing of plant and animal species into edible/non-edible products.
	4.4.4 C	Know energy sources derived from living things. (fossil fuels, ethanol, methane, etc.)	
3.1.4 A,B	4.1.3 C	Develop an awareness of careers in biotechnology.	

3.4.4 A	4.5.4 A	Identify the system of classification of pests.	(Conduct Individual Supervised Projects (SAE's) -- Collect pest specimens, identify and categorize, and write report(s) of influencing characteristics)
		Begin Grade 7	
3.4.7 A 3.1.7 A	4.4.7 A,B	Explain basic human, plant and animal needs: • Clothing • Food • Shelter • Space • Water	
3.4.7 B		Identify plant and animal cells, their parts and their functions.	
3.1.7 A,B	4.4.7 C	Understand the influence of biotechnological advancements on: • Food availability • Leisure time. • Farming practices of farmers from different cultures (ie: comparing Pennsylvania farmers to farmers from other cultures).	Biotechnology Timeline, **BLA #29**
3.1.7 B	4.4.7 B	Understand product modifications utilizing biotechnology. (wool, cotton, peanuts, mushrooms, etc.)	
	4.4.7 C	Understand the use of agricultural products to replace/supplement fossil fuels. • Anaerobic decomposition • Biochemical conversion	Biotechnology Timeline**, BLA #29** **Reference #3**, page 3.19-3.23, "Investigation of Industrial and Agricultural Uses of Biotechnology."
3.5.7 B	4.4.7 C	Investigate the cost for energy use of new technologies vs. the increased efficiency.	
3.1.7A,B	4.1.5 A,C,D,E	Exploring career opportunities in biotechnology. • Education requirements • Career titles • Starting salaries	Researching Careers in Biotechnology**, Reference #17** *Reference #17, "Biotechnology for Plants, Animals and the Environment", Unit II – Activity 4-1, "What's In a Job Description?"*
3.1.7 C	4.5.7 A	Benefits and harmful effects of pests. • Pest management • Affect on the environment	Design a simple pest management system for a garden. When is a pest not a pest? Activity, **Reference #16** pp 24-26
3.1.7 A 3.1.7 A,B	4.4.7 A, B	Identify environmental deficiencies and apply biotechnological solutions.	**Reference #3**, page 3.19-3.23, "Investigation of Industrial and Agricultural Uses of Biotechnology."
3.1.7 A 3.1.7 A,B	4.4.7 A,B	Inventory agricultural resources based on societal needs. Importance of agricultural systems.	

		• Natural • Human	
Begin Grade 10			
	4.4.10 C	Survey and assess consumers knowledge and attitudes about foods produced through biotechnology.	**Reference #17** "Biotech PAE'' Unit II, Activity 2-2 "Surveying Your Community About Biotech Foods" then interpret and report survey results.
3.1.10 A 3.5.10 B	4.4.10 C	Explain the use of biotechnology as it relates to: • The cost of energy. • Increased efficiency.	**Reference #1**, page 3, "History and Overview of Biotechnology in Agriculture." Genetic Engineering and Plant Food Production, PSU College of Agricultural Sciences, Finding the issue in the Hot House, Lesson #5 **Reference #3**, Pages 4.7-4.12, "The Transgenic Trout Debate." **Reference #4**, Unit 7, pages 1-31, "What is Risk?" **Reference #3**, Pages 1.13-1.25, "Biotechnology Uses and Aquacultural Uses."
3.4.10 C 3.1.10 B	4.4.10 C	Explain the use of problemsolving to address biotechnology issues.	
3.1.10 C	4.4.10 C	Describe a cost benefit analysis of genetically engineered plants and animals in comparison with traditional crops and breeds.	
3.7.10 A	4.4.10 C	Explain biochemical conversion.	
3.1.10 C	4.5.10 A 4.5.10 B	Effects of pests in different regions. Analyze health benefits and risks associated with Integrated Pest Management. • Mechanical control • Biological control • Chemical control • Cultural control	Write a paper comparing and contrasting the benefits and risks of integrated pest management in a specific geographical region.
3.1.10 C	4.5.10 A	Identify environmental effect(s) of pests on different regions of the world.	
Begin Grade 12			
3.1.10 A,B	4.1.8 (all)	Preparation and training for careers in biotechnology. • Identify skills necessary for entry level employment. • Identify skills necessary for post-secondary education requirements. • Acquiring skills	Researching Careers in Biotechnology, **Reference #17**
3.1.12 A	4.4.12 A	Analyze the impact of biotechnology research and advancements on management practices of agricultural producers.	**Reference #17**, "Biotechnology for Plants, Animals and the Environment", Unit I, Activity I.1, "How can biotechnology alleviate world hunger?"

3.1.12 A	4.4.12 B	Analyze and research the social, political and economic impact of the use of biotechnology in agricultural production.	(same as above)
3.1.12 B	4.4.12 C	Research and analyze the use of biotechnology in the development of crops as a fuel source.	
3.1.12 A	4.4.12 C	Compare and contrast agricultural research and development activities in biotechnology. • Application of agricultural research • Research procedures	Genetic Engineering and Plant Food Production, PSU College of Agricultural Sciences, Graphing the Data, lesson #2
3.1.12 C	4.5.12 A	Research and analyze the threshold limits of pests and the need for intervention in a managed environment.	Research the best management tools developed through biotechnology. Design and explain an IPM plan that uses a range of pest controls.
3.1.12 A,C	4.4.12 C	Analyze societal and cultural issues related to the introduction of genetically altered organisms.	Genetic Engineering and Plant Food Production, PSU College of Agricultural Sciences, Graphing the Data, Lesson #2 **Reference #3**, pages 4.13-4.17, "Aquacultural Biotechnology Ethics."
3.1.12 A,B	4.4.12 C	Research the impact of biotechnology on: • International environmental factors. • Alternative sources of energy • Management practices and processes of modern agriculture.	**Reference #17**, Unit III, Lesson 1, Products & producers of animal biotechnology, Activity 1-1.
3.4.12 C 3.1.12 A	4.4.12 C	Analyze impacts (limitations and concerns) of biotechnology in plant and animal reproduction. • Growth hormones • Invitro fertilization • Embryo transfer • Cloning • Genetic engineering	**Reference #17** "Biotech PAE" Unit III, Lesson 1, "Products and Producers of Animal Biotechnology" Unit III, Lesson 2 "Impacts of Animal Biotech" also – Unit III, Activity 2-1, "Will Animal Cloning Lead to Human Cloning?" Unit III, Lesson 4, "Cloning and Genetic Engineering of Animals" Unit III, Activity 4-2 "DNA Paternity Testing" then Describe the creation of a transgenic product and how it is being applied to animal agriculture. Unit II, Lesson 6 "Gene Transfer" then identify methods of gene transfer in plants. Unit II, Activity 6-1, "Creating Plant Protoplasts" Unit II, Activity 6-2, "Gene Transfer Using *Agerbacterium tumefaciens"* ***Research news articles and give class reports about the use of cloning to develop products related to plant and animals.***
3.1.12 B	4.5.12 B	Research and analyze IPM practices globally.	Research the best management tools developed with biotechnology. Design and explain an integrated pest management plan that uses a range of pest controls.
3.1.12 A 3.1.12 B		Preparation and training for careers in biotechnology. • Identify skills necessary for entry level employment. • Identify skills necessary for post-secondary education requirements. • Acquiring skills	Researching Careers in Biotechnology, **Reference #17**

		• Personality traits required for the job • Where education for the job can be obtained • Future of the job market • Job Locations	

Bio-Materials

Definition: Biomaterials are end products that are produced or altered by living organisms to enhance food and fiber production systems.

Rationale: Students understand how the production of bio-engineered products impacts society and food and fiber production systems.

PA Standards		Content	Activity
3.1.4 C 3.7.4 A	4.3.4 A	Explore the concerns of using biomaterials.	Scavenger hunt of biomaterials in the home
3.1.4 B 3.7.4 A	4.4.4 A	Identify products originating from bioengineered raw materials.	**Reference #3**, pages 5.13-5.18, "In Good Company"
3.1.4 B 3.7.4 A	4.4.4 B	Identify techniques of food preservation.	**Reference #3**, pages 5.13-5.18, "In Good Company"
3.7.4 A 3.1.4 B	4.4.4 B,C	Identify how substances are designed or altered to improve food and fiber products.	**Reference #17**, "Biotechnology for Plants, Animals and Environment", Unit I, Lesson 3, Activity 3-1, "Extracting DNA from wheat germ"
3.7.4 A 3.1.4 A	4.4.4 C	Identify how biotechnology processes are involved in improved efficiency in agricultural production.	Lesson 1 to 4 Biotech for Plants, Animals and Environment, Unit I "Fundamentals of Biotechnology")
Begin Grade 7			
3.7.7 A		Identify and determine use(s) of agricultural bio-material substances.	**Reference #17**, Unit II, Activity I-1, "Looking at products of plant biotechnology"
3.7.7 A		Describe methods for producing agricultural bio-materials.	(Same as above)
3.7.7 A	4.4.7 B,C	Identify plants and animals that can be raised in a geographical location and how it is addressed with altered species through bioengineering.	**Reference #3**, pages 1.23-1.24, "Finding a Future for Flounder and Antifreeze" **Reference #3**, page 1.25, "Aquaproduct Scavenger Hunt"
Begin Grade 10			
3.7.10 A	4.4.10 A	Compare a contemporary economic issue in agriculture to its historic origin through food and fiber development.	**Web Reference #2**, "It's Time to Eat" .
3.1.10 B 3.1.10 C		Investigate the application and development of biotechnologically engineered agricultural plants and animals.	
3.7.10 A 3.1.10 A		Design a production process that combines a naturally produced product with a humanly altered process to improve desirable traits.	**Reference #17**, Unit II, Activity 6-2, "Gene transfer using *agrobacterium tunefaciens"* **Reference #17**, Unit II, Activity 6-1, "Creating plant protoplasts"

		traits.	
3.7.10 A	4.4.10 C 4.8.10 B	Design and develop alternative methods for producing food and fiber.	Design and construct a system to produce bio-materials. **Reference #18**, Unit Lesson 3, "Using Biotechnology with Plants" Lesson 4, "Using biotechnology with animals"
3.1.10 B		Analyze how the use of bio-materials can satisfy specific human needs and improve the quality of life.	**Reference #17**, Unit I, Activity I-1 "How can biotech alleviate world hunger?"
		Begin Grade 12	
3.1.12 B,C 3.7.12 A	4.4.12 A	Research and analyze the development of alternatives to traditional: methods. • Pest Control • Fertilizers • Plant growing media	**Reference #6**, pages 207-224, "Exercise 15, Biological Control of Some Insect Pests"
3.1.12 C	4.1.12 B	Research emerging technologies from non-agricultural and non-traditional resources.	**Reference #6**, pages 207-224, "Exercise 15, Biological Control of Some Insect Pests"

Genetic Engineering

Definition: The deliberate manipulation of DNA to make or modify products; often applied as part of a traditional breeding program.

Rationale: The genetic engineering process offers great potential for solving health, environmental and food problems.

PA Standards		Content	Activity
3.1.4 B 3.7.4 A	4.4.4 A	Know that food and fiber products increase in variety and availability as a result of genetic engineering.	Create a food timeline.
3.1.4 B 3.7.4 A	4.4.4 A	Know that genetic engineering affects the diversity of: • Food products • Delivery system • Strength of strain	Have students interview family members about what constitutes a perfect fruit tree. Have the class develop a group set of priorities and design the ultimate fruit tree.
3.1.4 A 3.7.4 A	4.4.4 C	Understand that genetically engineered plants and animals are developed for commercial products and addressing energy needs.	Have students write and produce a commercial for a bioengineered animal.
3.1.4 B 3.7.4 A	4.4.4 C	Understand that genetic engineering is used to improve plant and animal products.	**Reference # 17** Biotechnology for Plants, Animals and Environment (National Council for Ag. Ed.) (Biotech PLE) Lesson 1, Table 1.1, "Biotech Applications in Ag"
3.4.4 C	4.4.4 C	Know that characteristics are inherited and that offspring closely resemble their parents.	
3.7.4 A		Understand the basics of food, fiber production and processing (planting, feeding, fertilizing, harvesting, etc.)	
Begin Grade 7			
3.1.7 A 3.7.7 A 3.3.7 A	4.4.7 C	Know the impacts of genetically engineered plants for the use in Integrated Pest Management.	**Reference # 17** (Biotech PAE) Unit II, Activity 2-1, "The Issues Around Herbicide Tolerant Plants" – Have students peruse current news magazines and science journals for articles about plant biotechnology to share with class; – Internet Activity: Have students access the University of Wisconsin "Why Files" (whyfiles.news.wisc.edu/062ag_gene_eng/index.html)
3.1.7 A 3.7.7 A	4.4.7 C	Discuss the impacts of genetically engineered plants, using herbicide tolerant or insect resistant plants as examples.	**Reference #17** (Biotech PAE) Unit II, Activity 2-1, "The Issues Around Herbicide Tolerant Plants"– Have students peruse current news magazines and science journals for articles about plant biotechnology to share with class;– Internet Activity: Have students access the

			University of Wisconsin "Why Files" (whyfiles.news.wisc.edu/062ag_gene_eng/index.html) .
3.4.7 B	4.4.7 C	Understand that every organism requires a set of genetic instructions in its nucleic acids for its inherited traits.	Have students individually investigate the creation and uses of transgenic organisms using the library, the internet, personal interviews or other methods. **Reference #17**, Unit I, Activity 4-1, "Rate of Inheritance"
3.1.7 A	4.4.7 A	Identify how energy use and technology are associated with genetic engineering through an historical overview.	**Reference #1**, pages 3-6 and videotape, Create a biotechnology timeline providing dates and ordering (supplementary reference: Pioneer Seeds and 10,000 years of Food Production).
3.1.7 A 3.7.7 A	4.4.7 C	Explain and compare the technologies that have enhanced agricultural production and processing.	**Reference # 17** (Biotech PLE) Activity 1-1 "How Can Biotech Alleviate World Hunger?")
3.4.7 C	4.4.7 C	Describe cell functions necessary for sustaining life.	**Reference # 17** "Biotech PAE" Unit I, Lesson 2, "Cells and DNA"
3.4.7 C	4.4.7 B	Identify the contribution of cellular components in agricultural biotechnology applications. • Hybrid plants • Genetically modified organisms	**Reference #1**, pages 7-13, "Understanding the Carriers of Heredity" **Reference #3**, pages 1.32-1.35, "DNA Building Blocks of Life" Incorporate cell part lessons, based on individual class needs, as a background builder before completing specific activities. **Reference #2**, Baking Bread Activity, comparing yeast as a form of biotechnology.
3.7.7 A	4.4.7 B	Identify methods of biotechnology that address food and fiber production issues. • Irradiation, cultivation, hybrid vigor, cross pollination, artificial selection in breeding	Pepper moth activity BLA#1023 **Reference # 17**, Unit II
Begin Grade 10			
3.7.10 A	4.4.10 C	Describe the process of producing transgenic plants by inserting one or more genes from a different source and their intended uses.	
3.7.10 A	4.4.10 C	Analyze increased efficiency in agriculture through introduction of genetic engineering.	Research and compare the technologies that have improved agricultural production. Conduct biotechnology related supervised agricultural experiences using field trials of transgenic crops such as Round-up Ready soybeans or BT corn, etc.
3.1.10 C 3.7.10 A	4.4.10 C	Compare traditional, new and emerging breeding techniques. • Embryo transfer • Cloning • Artificial breeding • Natural breeding • Hybridization • Tissue culture	**Reference #17**, Unit III, Activity 1-1, "Developing new products" Unit II, Lesson 2, "Impacts of animal biotechnology" Unit II, Lesson 7, "Plant tissue culture"

		• Invitro-fertilization	
3.3.10 B	4.4.10 A	Describe how genetic information is passed from one generation to the next.	Identify and contrast dominant, recessive, multiple allele and sex-influenced traits.
3.4.10 B		Explain cell functions in terms of chemical reactions and how they store and use information to guide their functions.	**Reference #17**, Unit I, Cells and DNA"
3.7.10 A	4.4.10 A	Explain how genetic information is transferred through various methods. • Traditional (cross pollination, sexual reproduction, artificial insemination) • Manipulated (mutation, gene transfer, in vitro fertilization, cloning)	**Reference #1**, pages 14-23, Paper Gene Splicing , Experiment pages 19-21 **Reference #6**, pages 105-113, Exercise 9, "Recombinant DNA Technology Plasmid Transformation" **Reference #3**, pages 1.64-1.71, "Developing a Transgenic Animal"
Begin Grade 12			
3.4.12 A	4.4.12 A 4.3.12 A 4.3.12 B 4.3.12 C	Research and discuss qualities of genetic diversity • Positive (vigorous organisms, varied traits, increased environmental change, introduction of engineered species to the ecosystem) • Negative (lower productivity, lower economic desirability, unforeseen impacts, introduction of engineered species into the ecosystem)	**Reference #1**, pages 37-41, "Analyze How Risky it is to do Certain Items" **Reference #3**, pages 4.29-4.36, "Global Issues in Aquicultural Biotechnology around the World" **Reference #6**, pages 91-104, "Exercise 8, Genes: Patterns of Inheritance"
3.4.12 C	4.4.12 C	Analyze the role of research and development in genetic engineering as it relates to: • the food and fiber system. • genetically engineered products.	**Reference #17**, Unit III, Activity 1-1, "Developing new products" and Unit III, Lesson 2, "Impacts of animal biotechnology"
3.4.12 C	4.4.12 A	At the molecular level, explain how genetic information is passed from one generation to another.	**Reference # 17** (Biotech PAE) Unit II, Activity 5-1 "Segregation and Independent Assortment—Punnet Square)
3.4.12 C	4.4.12 A 4.4.12 C	Discern the techniques involved for manipulating and moving genetic material (DNA) as part of the genetic engineering process.	**Reference #17**, Unit II, Lesson 6, Activity 6-1, "Creating plant protoplasts"

Medical Technology

Definition: The application of health wellness principles and theories to develop methods and tools that enhance the safe production of food and fiber and promote good health.

Rationale: The study of medical technology will expand student knowledge of how to sustain a viable and safe agricultural economy and become educated consumers.

PA Standards		Content	Activity
3.1.4 B	4.4.4 B	Understand the use of local and regional agricultural products from plants and animals for medicinal remedies.	Guest speaker: have a pharmacist or pharmaceutical representative discuss with the class the use of agricultural products and by-products in prescription and over-the-counter drugs.
3.1.4 B 3.7.4 A	4.4.4 A	Describe how biochemical technology has improved health wellness in daily life.	Summarize key concepts associated with the importance of biotechnology in medicine.
3.1.4 A		Understand differences between human medicine and veterinary medicine professions.	Have students describe how the work of a veterinarian differs from that of a physician; Activity: Investigate the meaning and use of bST growth hormone to promote increased milk production in dairy cows; Activity.
3.1.7 B 3.7.7 A		Identify and explain the impact that a specific medical advancement has had on society.	Research the use of animals in developing medical technologies for human organ transplants.
3.1.7 B	4.4.7	Identify production systems for medical products made available through biotechnology. • Vaccines • Donor Tissue from Animals Compare and contrast agriculture biotechnologically based medical treatment with a non-biotechnological alternative.	Create an art mural of vaccine history. Prepare a cost benefit analysis of biotechnological and non-biotechnological medical treatment.

Begin Grade 10			
3.7.10 A	4.4.10 A	Explain the variety of medical uses for biotechnology.	**Reference #3**, page 3.3-3.7, Lesson One: Human Health and Pharmaceuticals.
3.1.10 A	4.4.10 C	Understand differences between human medicine and veterinary medicine professions.	**Reference #17**, Unit II, Activity 1-1, "Looking at products of plant biotechnology"
3.1.10 B	4.4.12 C	Demonstrate an understanding of how biochemical technology affects medicine by designing a solution to a simple problem.	Access an Internet site for a company producing pharmaceuticals from animals and give a report.
Begin Grade 12			
3.7.12 A	4.4.12 A	Research and discuss the production of medicinal compounds in living organisms.	Research currently produced medicinal compounds that are grown and harvested from egg embryos. **Reference #6**, pages 65-74, Exercise 6, "Cells: Prokaryotic Diversity."
3.7.12 A	4.4.12 A	Analyze the effects of agricultural practices and bio-engineered products on the economics of the medical industry.	
3.7.12 A	4.4.12 A	Research and discuss a variety of applications of DNA based testing methods. • Medical • Agricultural • Legal	
3.7.12 A		Analyze specific examples where biotechnology has impacted society in protection and personal health application.	Research the development of : childhood immunizations, antibiotics, using biotechnology induced procedures for vaccines.

Regulation and Safety

Definition: The agriculture emphasis in regulations and safety is to ensure the safe production of food and fiber products, addressing protocols of public concern and safety.

Rationale: Food and fiber biotechnology production methods are rapidly increasing. Regulatory agency policies must ensure that new products/processes are safe and that appropriate propagation ethics are followed.

PA Standards		Content	Activity
3.1.4 B	4.2.4 B	Understand the need for personal cleanliness and how it is addressed through bio-engineered sanitation products.	**Reference #5**, "Germ Busters," page 121
3.1.4 C	4.4.4 C	Investigate human safety issues related to genetically engineered foods.	Develop a plan to engineer an original food product.
	4.8.4 A	Identify the individual's role as steward of environment.	Create a plan to preserve natural resources.
	4.9.4 A	Know that there are laws and regulations regarding the environment and human safety.	Discuss the effects that several laws have on the environment and economy (e.g. pesticide application licensing, solid and hazardous waste disposal, recycling, Clean Water Act, etc.).
3.1.4 A 3.7.4 C		Know that society uses science and technology advancements to produce new tools and techniques.	Discuss and evaluate the effect science and technology has on society.
Begin Grade 7			
3.1.7 A		Identify changes in society as a result of biotechnological developments.	**Reference #17**, Unit III, Lesson 1, "Products and producers of animal biotechnology"
	4.9.7 A	Identify laws and regulations regarding the environment and human safety.	Compare the various chemical application licensing procedures and certification processes.
	4.9.7 A	Explain the role of environmental laws and regulations pertaining to the environment and human safety.	Discuss the laws and regulations governing systems of pest control management, waste management, resource recovery, and the Clean Air and Water Act.
3.1.7 B	4.4.7 A	Explain how agriculture biotechnology affects society. • Economics	Select any biotechnology advancement and analyze it's impact on society.

		• Environmental Safety • Health • Standard of Living	
3.7.7 A	4.4.7 C	Identify the latest agricultural plant and animal products of biotechnology, the benefits and risks, the regulatory process and the career opportunities.	**Reference #17**, Unit II, Activity 8-1, "Plant Tissue Culture Propagation in Biotechnology and Plants"
3.7.7 A	4.4.7 C	Identify and describe how food safety issues impacted production in agriculture.	Activity: Discuss the 'Alar' pesticide application scare on apple production in the state of Washington.
3.1.7 C	4.3.7 B	Evaluate and describe potential risks, benefits and economic impacts through introduction of emerging scientific and technological advances.	Analyze and research the risks involved with the acceptance of any new method of food and fiber production.
	4.9.7 A	Explain the role of local and state agencies in enforcing food propagation, ethics, laws and regulations.	**Reference #17**, Unit II, Lesson 3, "Regulating New Plant Products"
		Begin Grade 10	
	4.4.10 A	Evaluate regulations on biotechnology products and processes.	**Reference #3**, pages 4.19-4.25, "Overview of Regulations."
3.1.10 B	4.4.10 A	Compare and contrast the influence of biotechnology in agriculture on a culture, standard of living and foreign trade.	
	4.4.10 B	Research and explain, past to present, food safety related technology.	Discussion of development of aseptic technique, instruction on current aseptic methods and student demonstration of basic aseptic lab skills. Students will participate in a field trip to a local food processing facility and see the sanitation and waste treatment techniques preformed and conduct a student-designed inspection. **Reference #4**, pages 14-19, 20, and 33-34.
	4.4.10 B	Research and explain how current product labeling laws are being used to regulate biotech products.	
3.1.10 C	4.7.10 C	Compare and contrast conventional and biotechnological processes and product impact on the ecosystem and human health.	Generate a cost benefit analysis.
	4.9.10 A	Explain why environmental and human safety laws and regulations are developed and enacted.	Compare the various chemical application licensing procedures and certification processes and why they are enacted.
	4.9.10 A	Analyze the role federal agencies play in regulating the development of new plant and animal products.	**Reference #17**, Unit II, Activity 3-1, "Regulating against insect resistance"

		Begin Grade 12	
3.1.12 C	4.4.12 A	Analyze the impact of biotechnology products and effects on quality of human life for producers and consumers. • Global Environment • Health • Safety	Research environmental safety of biotechnology products as they relate to humans and animals.
	4.4.12 A	Analyze the impact of nutrient management laws on PA agriculture.	Invite a nutrient management plan specialist and farmer into the class to discuss the impact of nutrient management laws on the economics of producing food and fiber.
3.7.12 A	4.4.12 C	Analyze the role of research, development and technology of bio-engineered food and fiber products from start to finish.	Students will design a bioengineered food product, determine what regulatory issues would arise and what governmental agency would oversee those issues, and contact those agencies to obtain regulatory approval information. In addition, patents and ethics for the product can be addressed and incorporated.
3.1.12 C	4.9.12 A	Compare and analyze laws and regulations that may have a positive or negative impact on the environment and economy. • Issues in genetic engineering • Issues in IPM	Research and discuss issues as they relate to genetic engineering and IPM systems.
	4.9.12 A	Analyze and explain how biotechnology issues lead to regulating new product development	Research and assess the role of regulatory agencies in monitoring public concerns and issues, and particular products produced through biotech techniques.

Resource Recovery

Definition: Application of practices that maintain a quality of living, a quality environment, adequate food and fiber products utilizing limited renewable and non-renewable resources while protecting air, water and soil resources.

Rationale: Students will understand that the efficient recovery, conservation and utilization of resources and waste by-products can help conserve scarce natural resources, reduce pollution and sustain a quality environment and economy.

PA Standards		Content	Activity
	4.9.4 A	Composting and recycling	Create a compost pile for lunch waste.
3.7.4 A	4.9.4 A	Identify waste management treatment processes.	Field trips of municipal and industrial waste treatment and/or recovery facilities
3.7.4 C		Identify waste and pollution resulting from a manufacturing enterprise.	Trace the potential air/water pollution of a specific enterprise and product.
Begin Grade 7			
3.7.7 C		Analyze manufacturing steps that affect waste and pollutants.	Redesign a manufacturing process to reduce or eliminate waste or pollution.
3.7.7 A		Define and describe biomass conversion as it relates to fuels and energy.	Research how biomass conversion (weeds/crops/animal manure) can produce useful energy. Field trip: manure to energy conversion at a large dairy farm
3.1.7 B	4.2.7 B 4.8.7 A	Evaluate factors affecting availability of natural resources.	**Reference # 20**, Topic 2 "Human Relationships with the environment", Lesson 3 "Appraising the Interdependence of humans and the environment"
	4.4.7 A	Investigate processes of environmental and human health issues addressed by the agricultural industry through bioengineered technology.	**Reference #3**, pages 3.9-3.12, "Environmental Benefits of Biotechnology"
3.7.7 A	4.9.7 A	Identify and describe the impact and treatment of waste on natural and human products.	Toxics Lesson Plan **BLA# 75**
3.1.7 B	4.2.7 B 4.8.7 A	Identify renewable and non-renewable resources and describe their uses.	**Reference # 20**, Topic 1, Lesson 1, SA-1 "Classifying our resources"

3.7.7 A	4.2.7 B	Identify the waste derived from the use of renewable and non-renewable resources.	**Reference #20**, Lesson 1, "What is waste?"
		Begin Grade 10	
	4.2.10 A	Apply knowledge of managing resources for protection and use. • Natural • Human Made Impact – Individual, societal, and environmental	
3.7.10 A	4.4.10 A	Review regulations and investigate economic impact of management of agricultural waste.	**Reference #3**, page 3.13-3.14, "Oil Eating Microbes"
3.7.10 A	4.9.10 A	Discuss how biotechnological changes and agricultural products may change waste management options.	Research how biomass conversion can reduce waste and increase energy options.
3.7.10 A	4.4.10 A	Demonstrate an understanding of how biochemical technology affects waste products by designing a solution that will result in reduced waste.	Research biochemical related technologies and propose alternatives in production/manufacturing procedures that result in less pollution.
3.7.10 C	4.4.10 B	Demonstrate an understanding of manufacturing by redesigning an enterprise to improve productivity, reduce or eliminate waste and/or pollution.	Demonstrate the degrading of a packaging material made with corn starch and those without corn starch. Have students discuss what they observed and also discuss other products that will help conserve natural resources and sustain the environment.
3.1.10 B	4.2.10 B 4.8.10 A	Analyze factors affecting the availability of renewable and non-renewable resources	**Reference #20**, Water Quality Unit, Lesson 1, "Identifying the Importance of water quality to humans"
		Begin Grade 12	
3.7.10 A	4.2.10 B	Analyze technologies that affect the use of natural resources	**Reference #20**, Management of Waste Unit, Lesson 2, "Preventing and reducing solid waste"
3.7.12 A	4.4.12 C	Appraise the cause and effect of impacts on the environment that result from biomass and biochemical conversions.	Cite the impacts on the environment if the emerging technologies are not utilized (e.g. manure, energy conversion, hydroponics, aquaculture, etc.)
3.7.12 A	4.4.12 A	Evaluate and apply the use of genetically altered bacteria in human and animal waste management.	**Reference #17**, Unit IV, Activity1-1, "Genetically engineered plants cleanup toxic wastes"
	4.4.12 B	Investigate the disposal of bio-engineered products.	**Reference #17**, Unit IV, Activity 4-1, "Phytoremediation"
	4.4.12 C	Analyze research and development as it relates to bio-engineered products; using microbes to clean up toxic wastes.	Research news articles and give a report of a bioengineered product used in reducing and/or cleaning up toxic wastes resulting from accidental spills.
3.7.12 A	4.2.12 B	Evaluate factors affecting the availability and use of natural resources and address ways of diminishing waste.	**Reference #20**, Management of solid waste Unit, Lesson 3, "Disposing of solid waste"

BIOTECHNOLOGY
Science Education

Agriculture: The science of raising plants and animals for food, clothing or other useful products. Agriculture utilizes biotechnology to improve plant and animal growth and development. (Proposed Environment and Ecology Standards 4.4B)

Definition: Agriculture is the science of cultivating the soil, producing crops and raising livestock and in varying degrees, the preparation and marketing of the resulting products. (Merriam-Webster Collegiate Dictionary, 10th Ed.)

Rationale: Agriculture is an applied science that utilizes biological information regarding plant and animal growth and development, and earth science including weather, climate, soil factors, erosion and runoff. Ecology is fundamental to agriculture in that we try to optimize biotic and abiotic factors to maximize product yield at minimum cost.

PA Standards		Content	Activity
3.3.4 A		Basic needs of plants: water, sunlight, nutrients Basic needs of animals: food, nutrients, water, shelter, space	Pennsylvania Society for Biomedical Research - Events Based Science Workshop Plants: Key Concepts for Gardening, Investigations in Science Plants, Creative Teaching Press p. 45-57 Animals: Science, Technology and Children Carolina Biological Supply Animal Studies (4), The Life Cycle of the Butterfly (K-2), Organisms (K-2), Soils (2-4) Delta Science Module, Behavior of Meal Worms
3.3.4 B 3.3.4 A		Inheritance Similarities and differences in living things	4H Junior Genes (K-4) Introduction to Adaptation **BLA#26**
3.3.4 C	4.6.4 C	Change over time	Science for the Real World Jenkins, Rice, Paige, and Blood p. 12-15 Observing Crickets Water, Stones, and Fossil Bones, Karen Lind, p. 92-120 activities for "The Earth's Past" Delta Science Module, Behavior of Meal Worms

3.3.4 D 3.1.10 D 3.3.10 B		Cells identity and function Scale as a way of relating concepts Described chemical basis of living organisms	4H Activity 2.1, As the Cell Turns (K – 4) Bubbling Bread, **BLA#30** Thick and Fast, **BLA #48** Thick and Fast, **BLA #48**
3.4.4 A		Chemical tests can be used to identify substances, (e.g., test with vinegar, iodine, pH indicator)	Science Technology, & Children, Carolina Biological Supply, Chemical Tests (3)
3.5.4 B		Basic importance of soils to hold plants and nurture life. Soils hold roots, provide nutrients, moisten via capillarity.	Science Technology, & Children Carolina Biological Supply, Soils (2-4) Wonder Science Volume 12 #3 American Chemical Society/American Institute of Physics Water, Stones, and Fossil Bones, Karen Lind, p. 10-29, 10 Activities for Soil Science
	4.2.4 A	Water cycle: evaporation, condensation, precipitation, runoff, infiltration, evaporation	
	4.4.4 A	Food, clothing, and shelter needs	Project Learning Tree Project Wild
	4.8.4 A	Impact of technology on environmental factors over time	Case study See samples: Morris Woods, The Apple Orchard. Other examples: clear-cut trees off a mountain, plow a field, macadam a parking lot. Students discuss technologies/tools needed to do this and harmful/beneficial results to quality of life.
	4.8.4 B	Technology's role on sustaining a quality of life	Activity: Read River Runs Wild
	4.8.4 C	Pollution and industry	
	4.8.4 D	International environmental issues	
Begin Grade 7			
3.3.7 A		Describe the similarities and differences that characterize diverse living things.	Fingerprinting! A lesson on classification, **BLA #19** Introduction to adaptation, **BLA #26**
3.3.7 B		Know that every organism requires a set of genetic instructions.	Mendel Bugs (Computer Program)
3.6.7 A		Explain biochemical-related technologies.	
3.8.7		Explain how sciences and technologies meet human needs and quality of life.	Activity: Transportation Impact
	4.2.7 A	Know that raw materials come from natural resources, (e.g. distinguish raw, or natural material from manmade, manufactured or refined material). Harvest raw material and refine or purify it.	
	4.4.7 A	Explain society's standard of living in relation to agriculture.	

	4.4.7 B	Use of natural and human resources	
Begin Grade 10			
3.3.10 A		Explain the causes, similarities and differences found among living things.	Generating Genetic Variation
3.3.10 B 3.3.12 A		Describe how genetic information is passed from one generation to the next.	Generating Genetic Variation Detailed study of compost microorganisms
3.3.10 C		Chemical and structural basis of living organisms	Constructing a Paper DNA Helix
3.3.10 D		Apply biochemical-related technology.	Bacterial Transfer More Juice From Apples, **BLA#51** Thick and Fast, **BLA#48**
Begin Grade 12			
	4.2.10 A	Explain food and fiber as natural resources.	
	4.2.10 B	Evaluate the effect consumer desires have on various natural resources.	
	4.4.10	Describe the importance of agriculture to society.	
	4.6.10 A	Biotic vs. abiotic factors	Bottle Biology
	4.6.10 B	Natural cycles	Bottle Biology
	4.6.10 C	Interruption of natural cycles	Bottle Biology
	4.7.10	Explain the significance of diversity in ecosystems.	Bottle Biology
3.3.12 B		Analyze the chemical and structural basis of living organisms.	Constructing a Paper DNA Helix
3.6.12 A		Analyze biochemical related technologies.	
	4.4.12 A	Diversity	
	4.5.12 A	Pest management	Monsanto's Transgenic Corn and Soy Paper Plasmids Transformation to understand transgenics
	4.5.12 B	Integrate pest management.	
	4.5.12 C	History of pest management	
	4.6.12 A	Interdependence of the ecosystem diversity and limiting factors	

Bio Materials

Definition: Material used for or suitable for use in living tissues. (Merriam-Webster Collegiate Dictionary, 10th Ed.)

Rationale: Biomaterials imitate living structure and functions and require knowledge of biochemistry, anatomy and physiology. Using biologic materials in not living applications is also a part of biomaterials and would include, for example, wool, silk and cotton industries, oil recovery, plastics and foodstuff.

PA Standards		Content	Activity
3.4.4 B		Combining two or more substances makes new materials with different properties.	Design a Washing Powder
3.6.4 A		Know biochemical related properties.	The Biodegradation of Oil by Aerobic Bacteria, **BLA#70** Design a Washing Powder Decomposition column Garbage Garden, **BLA#57** Bottle Biology
3.1.4 A		Know that natural and human made products are made up of parts.	Design a Washing Powder Bottle Biology
3.1.4 B		Know that models are useful imitations of objects and processes.	Constructing a Paper DNA Helix
3.8.4 A	4.2.4 A	Identify how human ingenuity and technological resources satisfy specific human needs and improve quality of life.	Make paper (See PLT, p. 51)
	4.2.4 B	Identify products derived from natural resources. Identify manmade products.	Plastic from Bacteria, **BLA#21** Yogurt With a Difference, **BLA#15** Yogurt With Another Difference, **BLA#16**
	4.4.4 A	Know the importance of agriculture to human needs.	
	4.4.4 B	Know that food and fiber originate from plants and animals.	Yogurt With a Difference, **BLA #15** Yogurt With Another Difference, **BLA#16**
Begin Grade 7			
3.3.7 B		Genetic instructions	Mendel Bugs (CBS) Virtual Fly Lab (Internet)
3.5.7 A		Explain biochemical-related technology. Know plant and animal processes.	Better Milk For Cats, **BLA#50** Grease Busters! **BLA#49**
3.8.7		Explain how science, human ingenuity and technology meet human	Grease Busters! **BLA#49**

		needs and the quality of life.	More Juice From Apples, **BLA#51**
	4.2.7 A	Know that raw materials come from natural resources.	PLT: Resource Go Around, p. 316
	4.2.7 B	Examine the renewability of the resources.	PLT: Reduce Reuse, Recycle, p. 320
	4.4.7 A	Explain a society's standard of living in relation to agriculture.	Research Activity
	4.4.7 B	Explain agricultural system's use of natural resources.	PLT: Reduce Reuse, Recycle, p. 320
Begin Grade 10			
3.3.10 B		Describe how genetic information is passed from one generation to the next.	Generating Genetic Variation - The Meiosis Game
3.3.10 C		Chemical basis of heredity	Constructing a Paper DNA Helix
3.3.10 D		Cellular functions	CBL Respiration Lab (Carolina Biological) CBL Osmosis Lab (Carolina Biological) Tooth Pick Enzyme Lab (Carolina Biological)
	4.4.10 A	Describe the importance of agriculture to society.	
	4.4.10 B	Compare and analyze different conditions for plant and animal growth.	
	4.6.10 A 4.6.10 B 4.6.10 C	Biotic vs. abiotic factors. Natural cycles/interruption of natural cycles.	Bottle Biology
Begin Grade 12			
3.3.12 A		Discern structural and functional relationships in living things.	Introduction to adaptation, **BLA #26**
3.3.12 B		Explain how genetic information is passed from one generation to the next at the molecular level.	Generating Genetic Variation: The Meiosis Game Extraction of Bacterial DNA Fish Protein Fingerprinting (Carolina Biological) Protein Assay Kit (Carolina Biological)
3.3.12 C		Explain the theory of evolution. Chemical basis	DNA Typing Constructing a Paper DNA Helix
3.3.12 D		Analyze the structural and chemical basis of living organisms' cellular functions.	Constructing a Paper DNA Helix DNA Spooling Fish Protein Electrophoresis, CBS DNA Your Onions (Practical Biotechnology) CBL Respiration Lab (Carolina Biological) CBL Osmosis Lab (Carolina Biological) Toothpick Enzyme Lab (Carolina Biological)
3.6.12 A		Analyze biochemical related technologies.	Yogurt with a difference, **BLA#15** Yogurt with another difference, **BLA#16**
3.6.12 A		Alternative to waste treatment	Biodegradation of Oil by Aerobic Bacteria, **BLA#26**
3.3.12 D 3.4.12 A 3.7.12 B 3.2.12 A 3.1.12 C		Enzyme activity Electrophoresis operations DNA basic structure Process skills of measuring volumes, and distance, regarding voltage gauges.	Crime Investigation & Building an Electrophoresis Chamber

Genetic Engineering

Definition: The directed alteration of genetic material by intervention in genetic processes. (Merriam-Webster Collegiate Dictionary, 10th Ed.) The formation of new combinations of heritable material by the isolation of nucleic acid molecules, produced by whatever means outside the cell, into any virus, bacterial plasmid, or other vector system so as to allow their incorporation into a host organism in which they do not naturally occur, but in which they are capable of continued propagation. Also, known as recombinant DNA technology (Walker and Cox, The Language of Biotechnology: A Dictionary of Terms)

Rationale: Since the human genome research, this topic has been expanding exponentially. Processes include benign activities such as selective breeding to radical transpecies gene transplants. This can include substitution, alteration or deletion of genetic material. The result can be new or improved species and valuable biochemicals. The impact of this new technology needs careful consideration.

PA Standards		Content	Activity
3.3.4 A 3.3.4 B 3.3.4 D		Observable similarities and differences in animals: size, color, number of appendages, shape, skeleton, habitat, covering Observable similarities and differences in plants: size, color, shape, habitat, structure	Compare Seeds. Make a face. Where is your peanut? **BLA#88**
3.6.4.A 3.3.4C		Growth and development - propagating, growing, maintaining, and preparation of organisms	Green Grows my Garden I Spy Critters
Begin Grade 7			
3.3.7 A 3.3.7 C 3.2.7 A 3.2.7 C 3.1.7A	4.6.7A	Life cycles - populations (groups of organisms of the same species from the same area) and communities (groups of species that interact in the same area)	Quick Frozen Critters - Project Wild, 1985
3.3.7 A 3.3.7 B 3.3.7 C 3.2.7 A 3.1.7 D		Distinguish between learned or acquired and inherited characteristics.	Classification Bingo Experiment - Getting the Point: Making Skin Sensory Comparisons Classifying Seeds Create a Robot Kingdom of Pasta

3.8.7 A			
Begin Grade 10			
3.3.10 A 3.3.10 C 3.2.10 A		Limiting factor: space, food, water	How Many Bears Can Live on this Food? Deer Feeding Activity Moisture Gradient Study
3.3.10 B 3.3.10 D 3.4.10 A 3.2.10 A		Terminology of DNA, gene, and chromosomes Triplicate code Structure of DNA	DNA - The Straw of Life Wheat Germ DNA Extraction Popeye's Delight: Spinach DNA Extraction DNA Spooling History, Hieroglyphics, and DNA: Cracking an Unknown Code What do you know about DNA? **BLA#66**
3.3.10 B 3.2.10 A		Mechanisms of inheritance Artificial selection and transgenic Natural selection	Marshmallow Meiosis Genetic of fungus - *Aspergillus Niualans*, **BLA#77** Genes that Melt in Your Mouth, Not in Your Hand **BLA#77** Pedigree Analysis: A Study of Alcaptonuria, **BLA#84** Beans and Birds: A Natural Selection Simulation
3.4.10.A		Separation of DNA fragments based on properties of the molecule	Rainbow Electrophoresis Paper DNA Fingerprinting**, BLA#75**
Begin Grade 12			
3.3.12 B 3.3.12 D 3.4.12 A 3.6.12 A 3.2.12 A 3.2.12 B 3.2.12 C 3.8.12 B		DNA fingerprinting Analyze biotechnologies	DNA Fingerprinting by Polymerase Chain Reaction and Restriction Fragment Length Polymorphism Techniques DNA Scissors DNA Goes to the Races FDA Regulation Awareness
3.3.12 B 3.3.12 D 3.4.12 A 3.2.12 A 3.1.12 B		Transcription and translation of DNA DNA basic structure.	Constructing a Paper DNA Helix From Genes to Proteins, **BLA#85** Protein Synthesis Project, **BLA#85** Generation of New Yeast Strains Using Electric Fusion
3.3.12 D 3.4.12 A 3.7.12 B 3.2.12 A 3.1.12 C		Enzyme activity Electrophoresis operations Process skills of measuring volumes, distance, regarding voltage gauges.	Crime Investigation & Building an Electrophoresis Chamber
3.2.7 B 3.8.7 C		Interpret data. Ethics	Fingerprinting
3.3.10 C		Modes of inheritance	Make a face

3.1.10 B		Use models to describe bio-process.	

Medical Technology

Definition: Concerns prevention of disease, assessment of health conditions and treatment of disease.

Rationale: This field uses scientific instruments and tools, reverse engineered drugs and ergonomically engineered devices that prevent and treat disease.

PA Standards		Content	Activity
3.2.4 A 3.2.4 B 3.1.4 A 3.1.4 B		Maintenance of teeth and the prevention of tooth decay	Teeth Lab - Dental Care, Observe two teeth. Soak one in milk and one is soda for several days. Observe to show breakdown.
3.4.4 A 3.2.4 A 3.2.4 B 3.1.4 A 3.1.4 B 3.1.4 C		Design an investigation to determine a strong bone and a weak bone. Design an investigation to see what happens when bones become demineralized. Properties of matter-solubility	Strong Bones/Weak Bones
3.3.4 A 3.3.4 D 3.2.4 A 3.2.4 B 3.1.4 A 3.1.4 B 3.8.4 A 3.8.4 B		How can we see inside living things? Things are made up of parts. How x-rays and stuff work.	Polaroid/Hand lens/mirror/Skeletal X-rays/MRI's
3.1.4 B 3.2.4 A 3.2.4 B 3.2.4 C		Understand the importance of enzymes in animal digestion.	Amylase/Saliva Swab Activity Carolina Tips/Carolina Biological Supply
Begin Grade 7			
3.3.7A 3.2.7 A 3.2.7 B 3.1.7 A 3.1.7 B		Build three dimensional paper models of the skeletal system and compare their diagrams with their models. How structure helps living things function.	Construction of Human Skeleton Dash

3.3.7 A 3.2.7 A 3.2.7 B 3.1.7 A 3.1.7 B		Compare the skeletons of rodents to humans.	Owl Pellets Construct skeletons of rodents and compare to the human skeleton. (Carolina Biological Supply)
3.2.7 A 3.2.7 B 3.2.7 C		Understand the role of the enzyme in commercial packing. Realize that enzymes become biologically inactive when denatured.	The case of runny Jell-O
Begin Grade 10			
3.2.10 A 3.2.10 B 3.2.10C		Explain and apply scientific and technological knowledge. Apply process knowledge. Identify and use elements of inquiry.	Introduction to enzyme specificity and inhibition Science Kit and Boreal Laboratories The case of runny Jell-O
3.2.10 A 3.2.10 B 3.1.10 A 3.1.10 B		Investigate how enzymes aid in digestion of proteins and starches.	Enzyme Experiment Kit Science Kit and Boreal Laboratories
3.2.10 A 3.2.10 B 3.1.10 A 3.1.10 B 3.8.10 A 3.8.10 B		Use enzyme specificity to show the antibody/antigen complex as it relates to the system.	Enzyme Lab, Starch and Amylase for fighting disease by matching antibodies to antigens, Your World, Our World, Vol. 3, Issue 2
Begin Grade 12			
3.8.12 A 3.8.12 B 3.3.12 D 3.2.12 A 3.2.12 B 3.1.12 A 3.1.12 B		Determine the source of an artificial epidemic.	A Microbial Detective Story Science Kit and Boreal Laboratories
3.3.12 D 3.7.12 A 3.7.12 B 3.7.12 C 3.7.12 D 3.2.12 A 3.2.12 B 3.1.12 A 3.1.12 B 3.8.12 A 3.8.12 B		Design an investigation to show a catalysis reaction that would normally occur in a biological system. Determine affects of changes in parameters on rate enzyme reaction.	Enzyme Catalyst Lab AP Biology Enzyme Catalysis Lab using CBL (Carolina Biological Supply) Note: This lab can be done without using the CBL.

3.3.12 B 3.3.12 D 3.6.12 A 3.7.12 A 3.2.12 A 3.2.12 B 3.1.12 A 3.1.12 B 3.8.12 A 3.8.12 B		Show how genes can be transferred between species. Show how bacteria can be used to produce proteins from animals.	Bacterial Transformation pGLO Kit GFP Lab (Gene Transfer Lab)
3.3.12 B 3.3.12 D 3.6.12 A 3.7.12 A 3.2.12 A 3.1.12 A 3.1.12 B 3.8.12 A 3.8.12 B		Determine resistance of bacteria to an antibiotic.	Antibiotic Resistance Lab Conferring antibiotic resistance in bacteria Science Kit and Boreal Laboratories (see: http://www.sciencekit.com/classact.htm)
3.7.12 A 3.7.12 B 3.7.12 C 3.7.12 D 3.2.12 A 3.2.12 B 3.2.12 C 3.1.12 A 3.1.12 B 3.1.12 C 3.1.12 D 3.8.12 A 3.8.12 B		Develop an investigation to show the basis of human immunity. Show the sensitivity and specificity of a diagnostic test (ELISA Test).	Diagnosis of disease, based on immune response A Virtual Laboratory Exercise (ELISA test) Howard Hughes Medical Institute

Regulations and Safety

Definition: The science emphasis in regulations and safety are in maintaining aseptic techniques. Teachers are cautioned to follow proper protocols and contact Fisher Scientific, OSHA and the National Science Teachers Association. See http://csss.enc.org/safety.htm for safety related web sites.

Rationale: Microbiology technique and general laboratory safety forms the scientific base of this strand**.**

PA Standard		Content	Activity
3.2.4 A 3.2.4 B 3.3.4 A	4.3.4 A	Understand some living things are very small and float in the air. Bacteria and yeast are carried in the air. Complete a one step experiment and recognize a variable in an investigation.	Bread and Hand Investigation D.A.S.H.
3.7.4 A 3.7.4 B 3.2.4 A 3.2.4 B 3.2.4 C		Gain awareness of environmental conditions in the student's school and community. Living things grow better in some conditions than others. Some unknown living things might be dangerous. Covering food slows or prevents contamination.	What's In the Air?
3.7 4 A 3.7.4 B 3.2.4 A 3.2.4 B 3.2.4 C		Discover different life in local water sources. Treated water has less life in it than non-treated stream/pond water samples. Some living things will only grow in clean fresh water.	What's In Water? **BLA#12**
3.3.4 A 3.3.4 B 3.3.4 C 3.2.4 A 3.2.4 B		Compare "store bought" bread to "home made" bread for mold resistance.	Store Bought vs. Home Made, **BLA#43**
3.6.4 A 3.7.4 A 3.2.4 A 3.2.4 B		Gain awareness of how unwashed hands can "spread" possible pathogens to all areas that hands contact.	Pathogens; the spreading of Model pathogen spreading by hand to hand contact. Students powder their hands at the beginning of the day. At the end of the day, black light the students' hands, face, work area and environment. Observe the changes over a number of days.
3.2.4 A 3.2.4 B 3.2.4 C		Test for presence of phosphates, pH, chlorides and lead. Explain non-living contamination.	How Clean is the Water? Science Kit and Boreal Lab (see: http://www.sciencekit.com/classact.htm)

3.7.7 A 3.7.7 B			
Begin Grade 7			
3.6.7 A 3.7.7 A 3.2.7 A 3.2.7 B		Determine what techniques, procedures and hygienic conditions would be required to make a product fit for human consumption.	Make Yogurt - what must we do to make it "eatable"? Microbial Fermentation Lab (emphasize the cleanliness needed to make the product consumable by humans) Science Kit and Boreal Lab
3.7.7 A 3.7.7 B 3.2.7 A 3.2.7 B 3.2.7 C		Collect and analyze water samples for microbial pollution.	Microbial Flora of Polluted Water Science Kit and Boreal Lab (see: http://www.sciencekit.com/classact.htm)
3.6.7 A 3.7.7 A 3.2.7 A 3.2.7 B 3.3.7. D 3.6.7 A 3.7.7 A 3.2.7 A 3.2.7 B		Understand the importance of hand washing effectiveness in the prevention of microbe growth.	Pathogens; the spreading of Students powder their hands at the beginning of the day. At the end of the day, black light the students' hands, face, work area and environment. Observe the changes over a number of days. Are Your Hands Clean? Before lunch, after the students said their hands were clean, have them put their hands in a petri dish for growth. Observe the changes over a period of days.
3.3.7 D 3.2.7 A 3.2.7 B		Skin protects and stops the spread of germs.	Skin for Protection: Science for the Real World, Pg. 67
Begin Grade 10			
3.6.10 A 3.7.10 A 3.2.10 A 3.2.10 B		Understand the safety and importance of aseptic technology and practice critiquing violations and possible consequences.	Student Self Design Regulations, **BLA#42**
3.6.10 A 3.7.10 A 3.2.10 A 3.2.10 B		Understand the link between personal decisions and body fluid disease.	Body Fluid Transmission Activity, **BLA#38**
3.3.10 A 3.7.10 A 3.7.10 B 3.2.10 A 3.2.10 B		Distinguish between qualitative and quantitative information. Sample areas in the community to determine pathogen location.	Collection and Identification of Bacteria From Community, **BLA#37**
3.7.10 A 3.2.10 A		Determine what chemical is potentially marketable and sequentially purify it.	Secrets of the Rain Forest Bio Rad Corp.(see: http://www.bio-

3.2.10 B			rad.com/B2B/BioRad/br_start.jsp)
Begin Grade 12			
3.2.12 A 3.2.12 B 3.2.12 C 3.1.12 A 3.1.12 B 3.1.12 C 3.8.12 A 3.8.12 B 3.8.12 C		Using industry standards, separate unknowns into component parts.	Column Chromatography Bio Rad Corp. (see: http://www.bio-rad.com/B2B/BioRad/br_start.jsp)
3.7.12 A 3.7.12 B 3.2.12 A 3.2.12 B	4.3.12 A 4.3.12 B 4.9.12 A 4.4.12 A	Become aware of regulations for medical services, agriculture related feed, injectable drugs and oral drugs.	Scenario: Teacher creates scenarios for the students to evaluate whether or not the regulations are adhered to - in the area of handling equipment that will be used to produce drugs, medical devices, Ag. related medicated feed, injectable drugs, oral drugs **BLA#38**
3.2.12 A 3.2.12 B 3.2.12 C 3.1.12 A 3.1.12 B 3.1.12 C 3.8.12 A 3.8.12 B 3.8.12 C 3.2.12 D	4.3.12 A 4.3.12 B	Evaluate the effectiveness of commercial products in controlling bacteria. Determine the ability of commercial products to help the production of "super bacteria" (a genetic engineered and adapted organism). Includes helpful, insulin producing, and harmful, staph strains. Use resources to solve society's problems. Evaluate consequences. Assess the impacts of solutions.	The Effectiveness of Commercial Soaps, **BLA#40** FDA regulation awareness

Resource Recovery

Definition: Reclaiming the original material. Includes recycling but includes retrieving not only the natural resource and the biomaterial in its original and functional form.

Rationale: While recycling and reusing materials has long been practiced, in biotech applications, this cycling of material recovers useful resources.

PA Standards		Content	Activity
3.3.4 A 3.3.7 A 3.3.7 B	4.2.4 D 4.2.7 D 4.3.4 C 4.3.7 C 4.6.4 A 4.6.7 A	Organic recycling Life cycle of corn	How Much Garbage Can a Work Worm Eat?
3.3.4 A 3.3.4 B 3.3.4 D 3.5.4 C 3.6.4 A 3.7.4 B 3.2.4 A 3.1.4 A 3.1.4 C	4.2.4 A 4.2.4 D 4.3.4 A 4.3.4 C 4.4.4 A 4.4.4 B 4.6.4 A 4.6.4 B 4.7.4 B	Look at composting, decomposing and degradation of materials. Identify various sources of waste and pollution. Plant growth and development Plant parts Soils Measurements	No Work Leaf Garden, **BLA#35**
3.5.4 D 3.6.4 A 3.7.4 A 3.2.4 A 3.2.4 B 3.1.4 B 3.8.4 A 3.8.4 B	4.1.4 A 4.1.4 B 4.1.4 C	Water quality Impact of waste and pollution on environment/society Organisms and their environment	Clean Water-Where Does it Come From

Begin Grade 7			
3.4.7 A 3.5.7 C 3.6.7 C 3.2.7 C 3.8.7 A 3.8.7 C	4.2.7 C 4.3.7 A 4.3.7 B 4.6.7 B 4.8.7 A 4.8.7 B 4.8.7 C 4.9.7 A	Identify the impact of waste and pollution on the environment and society. Air quality	Collect Ozone Data Know Your Ozone
3.4.7 A 3.4.7 A 3.4.7 C 3.5.7 C 3.6.7 A 3.2.7 C 3.2.7 A 3.1.7 A 3.1.7 B 3.1.7 C 3.8.7 C	4.3.7 A 4.3.7 B 4.8.7 C 4.9.7 A	Impact of waste on environment Molecular structure of stratospheric ozone Atmospheric layers Use of models as an application of science concepts.	"Hole"-Y Ozone! It's the CFC's, **BLA#25** Recovery of useable products from organic materials
3.5.7 B 3.6.7 A 3.6.7 C 3.2.7 A 3.2.7 B 3.8.7 A 3.8.7 B 3.8.7 C	4.2.7 A 4.2.7 B 4.2.7 C 4.2.7 D 4.3.7 A 4.3.7 B 4.8.7 A 4.8.7 B 4.8.7 C	Hidden costs in products Economic and environmental impacts in manufacturing Recycling/management Integration of science, technology, and society Green design Explain how human activities may affect local, regional and national environments.	Life Cycle Analysis of a T-Shirt, **BLA#23** Toxics lesson plan, **BLA#75**
3.5.7 B 3.5.7 D 3.6.7 A 3.6.7 C 3.1.7 B	4.1.7 A 4.2.7 B 4.3.7 A 4.8.7 B 4.8.7 C 4.8.7 D 4.9.7 A	Water quality Impact of pollution on water quality Protection of water quality How does a natural resource manage water quality? Impact of pollution on water quality Protection of water quality How is a natural resource managed?	"Build Your Own Aquifer" EPA Environmental Education - Office of Water http://www.epa.gov/safewater/kids http://www.groudwater.org/learn/top_ten.htm
Begin Grade 10 and 12			
3.3.10 A 3.3.12 A 3.6.10 A 3.6.12 A	4.2.10 D 4.2.12 D	Composting components Sampling invertebrates Culturing microorganisms	Detailed Study of Compost Microorganisms

3.6.10 A	4.2.10 D	Traditional treatments of waste pollution Recycling and conversion - illustrate how a natural resource is managed through reduction, recycling and re-use.	Investigating the Uses of Backyard Bacteria, **BLA#14**
3.6.12 A	4.2.12 D 4.8.10 C 4.8.12 B 4.8.12 C	Identify biochemical and biotechnological ways to deal with waste and pollution- combined with traditional methods. Recycling technology Remediation technology	The Biodegradation of Oil by Aerobic Bacteria, **BLA#26**
3.4.12 B 3.4.12 C 3.5.12 B 3.6.12 A 3.2.12 A 3.1.12 A 3.8.12 C	4.2.12 A 4.2.12 B 4.2.12 C 4.2.12 D 4.3.12 A 4.3.12 B 4.3.12 C 4.4.12 B 4.4.12 C 4.8.12 A 4.8.12 B 4.9.12 A	Identify biochemical and biotechnological ways to deal with waste and pollution - combining with traditional methods. Recycling technology Remediation technology	What is a “Green Product?”
3.2.12 A 3.4.12 C 3.5.12 B 3.6.12 A 3.2.12 A 3.1.12 A 3.8.12 C	4.2.12 A 4.2.12 B 4.3.12 A 4.3.12 B 4.3.12 C 4.4.12 B 4.4.12 C 4.8.12 A 4.8.12 B 4.9.12 A	Explore the impact of technology/production on the environment. Explore “bio-realism” (the integration of nature and human design)	What is a “Green Product?”
3.1.10 B 3.2.7 B 3.2.10 B 3.4.7 B 3.6.7 A 3.6.10 A 3.7.7 A 3.7.10 A		Use of models to understand science and technology Apply process knowledge Relate energy sources and transfers to heat and temperature. Explain biotechnologies as they relate to technologies of conversion. Safe and appropriate use of tools and techniques	Recovery of Usable Products from Organic Materials

BIOTECHNOLOGY
Technology Education

Agriculture

Definition: Agriculture is the process that utilizes plants and animals to produce products that satisfy human needs and wants.

Rationale: The importance of agriculture in human existence and development has existed since the beginning of time. People should be conscious of the fact that plants and animals help us to satisfy basic human needs and wants. Agricultural systems and resources interact to impact individuals, society and the environment. Knowledge and resources of agricultural systems affect individuals, society and the environment.

PA Standards		Content	Activity
3.8.4 A 3.8.4 B		Understand the importance of agriculture. • Basic needs of people and animals (food, shelter, water, space) • Satisfying wants of humans • International • Environment	Identify and explore food and clothing products. Design a structure for farm animals related to literature reading. Design simple farm tools – operation/function.
3.3.4 A 3.3.4 B 3.6.4 A 3.2.4 C 3.1.4 C		Know origins of agricultural products. • Conditions for plant and animal growth • Types of agricultural products • Agricultural systems (natural and human altered)	Evolution of agricultural tools and machines.
3.5.4 B 3.5.4 C 3.2.4 A 3.2.4 B		Know the application of technology. • Importance of tools in agriculture • Innovations and inventions • Careers	Apply various types of soil for appropriate plant growth. Design and construct a scale model of a tool/machine. Explore use of mechanization, chemicals – discuss positive and negative.

Begin Grade 7			
3.5.7 B		Explain importance of agriculture. • Basic needs of people and animals • Satisfying wants of humans • International implications	
3.1.7 C		Explain origin of agricultural products. • Conditions for plant and animal growth • Agricultural systems (natural and human altered)	
3.6.7 A 3.2.7 B 3.1.7 A 3.1.7 B 3.1.7 C		Explain application of technology. • Importance of tools in agriculture • Innovations and inventions • Biochemical conversion (fermentation, anaerobic decomposition)	
3.8.7 A 3.8.7 B 3.8.7 C		Explain impacts of agriculture. • Individuals • Society • Environment • Careers	
Begin Grade 10			
3.8.10 A 3.8.10 B		Apply the importance of agriculture. • Basic needs of people and animals • Satisfying wants of humans • Global	
3.3.10 C 3.5.10 B		Describe the origins of agricultural products. • Conditions for plant and animal growth • Types of agricultural products • Agricultural systems (natural and human altered)	Track and quantify use of products – modeling. Design and construct a water filtration system – irrigation.
3.5.10 B 3.6.10 A 3.6.10 C 3.7.10 A 3.2.10 A 3.1.10 B		Evaluate the application of technology. • Importance of tools in agriculture. • Innovations and inventions. • Biochemical conversion (fermentation, anaerobic decomposition.)	Design and construct a new agriculture tool – testing and altering.

Begin Grade 12			
3.5.12 B 3.8.12 A 3.8.12 C		Evaluate the impacts of agriculture. • Individuals • Society • Environment • Careers	Examine impacts of agriculture community – jobs, economics, pollutants, etc.
3.3.12 A 3.3.12 B 3.3.12 D 3.2.12 B		Analyze and evaluate importance of agriculture. • Basic needs of people and animals • Satisfying wants of humans • International	Design and construct an environment that will support plant growth.
3.5.12 C 3.6.12 A 3.6.12 C 3.7.12 A 3.7.12 C 3.2.12 A 3.2.12 B 3.2.12 C 3.1.12 B 3.8.12 B		Analyze and evaluate generating agricultural products. • Genetics • Agricultural systems (natural, human altered)	Design and construct a model to simulate effects of fertilization.
3.5.12 D 3.6.12 A 3.2.12 C 3.8.12 A 3.8.12 C		Analyze and evaluate applications of technology. • Importance of tools in agriculture • Innovations and inventions • Biochemical conversion (fermentation, anaerobic decomposition)	
		Analyze and evaluate impacts of agriculture. • Individuals • Society • Environment • Careers	Design and construct models to simulate land use, soil erosion, soil revitalization and water concerns as related to agriculture.

Bio-materials

Definition: Bio-materials are substances that are produced or altered by organisms, primarily microorganisms, to satisfy human needs and wants.

Rationale: Students should understand how these bio-materials are designed and produced. They should also understand how they are used and be able to assess their impact on individuals, society and the environment

PA Standards		Content	Activity
3.6.4 A 3.6.4 C		Understand how substances are designed to meet a human need or want. Identify substances as naturally produced or human altered. Know that natural and human altered products are made up of parts that operate together in a systematic way.	Compare natural, compost and chemical fertilizers.
	4.4.4 A 4.4.4 B	Understand how substances are produced to meet a human need or want. Know that food and fiber originate from plants and animals. Know the importance of agriculture to meet human needs.	
3.8.4 A		Identify how humans use resources to produce products that satisfy specific human needs and wants.	Sprout seeds, introduce fertilizers (natural, compost, chemical) and compare the effects.
3.6.4 A 3.8.4 A		Understand how substances are used to meet a human need or want. Identify bio-materials that are used to meet human needs or wants.	
3.8.4 C	4.3.4 B	Assess the impact of substances on individuals, society, and the environment. Identify concerns that people have about using bio-materials.	Current event activity
Begin Grade 7			
3.6.7 A 3.2.7 B		Understand how substances are designed to meet a human need or want. Explain design methods for bio-materials.	Design a system to produce bio-materials.
3.1.7 A 3.1.7 B 3.8.7 B		Understand how substances are produced to meet a human need or want. Explain production methods for bio-materials.	Use a system to produce a bio-material.
3.6.7 A 3.8.7 A		Understand how substances are used to meet a human need or want. Determine use(s) of bio-material products.	
3.2.7 C 3.8.7 B		Assess the impact of substances on individuals, society, and the environment. Explain concerns society has with the production of bio-materials.	

Begin Grade 10			
3.6.10 B 3.2.10 B		Understand how substances are designed to meet a human need or want. Compare and contrast design techniques using bio-materials to solve problems.	Design and construct a working system that will produce bio-materials.
3.1.10 A 3.1.10 B		Understand how substances are produced to meet a human need or want. Compare and contrast bio-material production systems.	Students use their working system to produce a bio-material.
3.6.10 A 3.1.10 A		Understand how substances are used to meet a human need or want. Asses the utilization of bio-materials in society.	Students utilize the bio-material product that was produced from their system.
3.2.10 C		Assess the impact of substances on individuals, society and the environment. Assess the effectiveness of a bio-material production system.	Assess the effectiveness of a system and propose alternatives.
Begin Grade 12			
3.2.12 B		Understand how substances are designed to meet a human need or want. Analyze design techniques using bio-materials to solve complex problems.	Design a new or alter an existing production process involving bio-materials.
3.1.12 A 3.1.12 B		Understand how substances are produced to meet a human need or want. Analyze more than one biochemical process used in the production of bio-materials. Analyze a process that uses bio-materials to produce a product.	Involve more than one biochemical process to produce a bio-material.
3.6.12 A		Understand how substances are used to meet a human need or want. Analyze ways of using bio-materials on individuals, society and the environment on a global scale.	Design and test a way to use bio-materials on / with individuals, society and the environment on a global scale.
3.2.12 C	4.8.12 B	Assess the impact of substances on individual, society and the environment. Analyze the effectiveness of bio-materials on individuals, society and the environment on a global scale.	Critically evaluate all aspects of a system that uses or produces bio-materials and propose alternatives.

Genetic Engineering

Definition: The deliberate manipulation of DNA to make or modify products**.**

Rationale: Genetic engineering continues to offer great potential for solving world health and food problems. The study of Genetic Engineering will gain importance as its impacts on society increase.

PA Standard		Content	Activity
3.3.4 A 3.3.4 B 3.3.4 C	4.4.4 A 4.4.4 B 4.9.4 A	Understand food and fiber production and processing. • Know that food and fiber originate from plants and animals. • Select the desirable characteristics. • Identify people's basic needs. • Identify careers that are associated with food and fiber production and processing. • Know that guidelines govern food and fiber production and processing.	Identify which products come from which organisms. Compare fabric materials. Discuss farm recycling.
3.3.4 A 3.3.4 B 3.6.4 A	4.4.4 B 4.4.4 C 4.5.4 C 4.5.4 B 4.5.4 C	Identify the technology and energy use that is associated with food and fiber production and processing. • Know types of pests and methods of pest management. • Identify what plants and animals need to grow.	Imitate natural pesticides with household items. Compare manual pest management and chemical pest management. Farm alfalfa, feed to cows, dump manure into fields.
3.3.4 A 3.4.4 A 3.8.4 B	4.2.4 A	Identify and distinguish organic materials. • Distinguish between living and nonliving things. • Identify substances as naturally produced or human altered.	Compare plastic and cotton. Compare cotton and fleece products.
3.4.4 A 3.6.4 A 3.6.4 B 3.1.4 A 3.8.4 A	4.4.4 A 4.4.4 C	Know that natural and human altered products are made up of parts and operate together in a systematic way. • Know how genetically engineered substances can be used. • Know the importance of agriculture to human needs. • Identify genetically engineered organic materials that meet human needs and wants.	Relate grocery stores to farms. Understand how insecticides allow larger produce and bigger yield. Flavor savor tomatoes – modify.
3.8.4 C	4.3.4 B	Identify concerns that society has with using genetically engineered materials.	Understand that there is a loss of the dependence on nature.
		Identify careers that are associated with genetically engineered materials.	
3.8.4 C	4.9.4 A	Know that guidelines govern genetically engineered materials.	Introduce Food and Drug Administration.
See Resource Recovery For Related Information			

Begin Grade 7			
3.3.7 A 3.3.7 B 3.3.7 C 3.6.7 A 3.7.7 A 3.7.7 B 3.2.7 A 3.2.7 B 3.1.7 A 3.1.7 B 3.1.7 C 3.8.7 A 3.8.7 B 3.8.7 C	4.4.7 A 4.4.7 B 4.4.7 C 4.5.7 A 4.5.7 B 4.5.7 C 4.9.7 A	Explain food and fiber production and processing. • Explain the improvement of food and fiber production and processing through the use of technology. • Explain why food and fiber production and processing selects organisms with desired characteristics. • Assess the needs of animals and the needs of plants. • Explain issues as they relate to genetic engineering and integrated pest management systems. • Identify careers associated with genetic engineering in the food and fiber production and processing areas. • Assess the technologies used to meet the needs of plants and animals based on societal demands.	Compare and contrast the technologies that have advanced production and processing. Design a system to select organisms with desired characteristics. Compare the needs of animals as they interact with plants and plants as they interact with animals. DDT/Agent Orange. Discuss the laws and regulations governing plant and animal technologies.
3.6.7 A 3.8.7 A 3.8.7 B 3.8.7C	4.4.7 A 4.4.7 B 4.4.7 C 4.9.7 A	Understand and distinguish organic materials. • Understand how genetically engineered materials are designed to meet a human need or want. • Explain how technology has improved genetically engineered materials. • Explain issues as they relate to genetically engineered materials. • Identify careers related to genetically engineered materials.	Explain the need to grow crops in low rainfall areas. Describe the flavor savor tomato. Understand the importance of disease resistant crops. Understand why the world seed bank, saving old seeds which have genetic resistance to disease, is important.
3.3.7 B 3.7.7 A 3.7.7 B 3.8.7 C	4.4.7 A 4.4.7 C 4.9.7 A	Assess how technology has improved genetically engineered materials. • Explain agricultural systems used to aid the production of genetically engineered materials. • Explain how guidelines govern genetically engineered materials.	How has technology helped research? Contrast with organic farming.
3.6.7 A		Explore how healthcare maintenance and treatment have genetic engineering links. • Vaccines, dead, live, attenuated live, pharmaceuticals • Identify careers associated with genetic engineering in health care.	Video, teleconference, or field trip to genetic or bio lab.
See Resource Recovery For Related Information			

Begin Grade 10			
3.6.10 A 3.6.10 B 3.7.10 A 3.7.10 B 3.7.10 D 3.2.10 B 3.1.10 B	4.5.10 A 4.5.10 B 4.5.10 C 4.9.10 A	Evaluate food and fiber production and processing. • Determine the effect of applying the technology of genetic engineering as it relates to food and fiber production and processing. • Assess integrated pest management practices as they relate to food and fiber production and processing. • Assess local, state and national laws and regulations that deal with genetic engineering in the food and fiber system. • Research various career paths in genetic engineering as related to food and fiber production and processing.	Design and construct a model that will separate products of genetic engineering on the basis of chemical, biological and/or physical properties. Model the application of integrated pest management practices to food and fiber production and processing. Design an integrated pest management system. Design a job advertisement for a genetic engineering position in the food and fiber system.
3.3.10 B 3.3.10 D 3.1.10 B 3.8.10 B 3.8.10 C	4.4.10 C 4.5.10 B 4.5.10 C 4.9.10 A	Understand and distinguish organic materials. • Determine the effect of applied technology as it relates to genetically engineered materials (biological, chemical, physical.) • Analyze the application of various technological advancements in genetic engineering to increase efficiency in agriculture (biological, chemical, physical.). • Assess local, state and national issues and/or laws associated with genetically engineered materials. • Assess various career paths and/or businesses associated with genetically engineered materials.	Discuss how the crossing of legumes (which fix N with tomatoes) helps to produce more perfect vegetables. Understand how science can breed crops to bear fruit in a desired size and place on the plant. Research Food and Drug Administration. Research various career paths and/or businesses associated with genetically engineered materials.
3.6.10 A		Understand healthcare technology as it relates to genetic engineering. • Assess the genetic engineering links in healthcare maintenance and treatment (immunization, pharmaceuticals, organ transplants). • Assess various career paths and/or businesses associated with genetic engineering in health care.	Describe the concept of breeding cultures. Research various career paths and/or businesses associated with genetic engineering in health care.
See Resource Recovery For Related Information			

Begin Grade 12			

	4.4.12 A
	4.4.12 B
		Assess food and fiber production and processing.
		• Analyze management practices in food and fiber production and processing.
		  • Explore and analyze businesses that are involved in genetic engineering.
		  • Discuss social, political, economic and ethical issues.
		  • Analyze the complex issues in plant and animal genetic engineering.
		  • Analyze a food or fiber system based on a need in society that integrates genetic engineering, integrated pest management and regulation and safety issues.
		  • Analyze a possible career path in genetic engineering as it relates to food and fiber production and processing.
			Research and develop a food or fiber system based on a need in society
			that integrates genetic engineering, integrated pest management and regulation and safety issues.
			Select a possible career path in genetic engineering and communicate with a company or individual involved in that career path.

3.3.12 B 3.6.12 A 3.7.12 A 3.7.12 B 3.2.12 A 3.2.12 B 3.2.12 C 3.8.12 A 3.8.12 B 3.8.12 C	4.4.12 A 4.4.12 B 4.4.12 C 4.5.12 A 4.5.12 B 4.5.12 C 4.7.12 A 4.7.12 B 4.7.12 C 4.8.12 A 4.8.12 B 4.8.12 D	Analyze a genetically engineered material that integrates integrated pest management, regulation and safety issues, and social, political, economic and ethical concerns. • Analyze a possible career path in genetic engineering.	Research and develop a presentation/display on a genetically engineered material that integrates integrated pest management, regulation and safety issues, and social, political, economic and ethical concerns. Select a possible career path in genetic engineering and communicate with a company or individual involved in that career path.
3.6.12 A 3.8.12 A		Understand health care as it relates to genetic engineering. • Analyze genetic engineering links in healthcare maintenance and treatment (immunization, pharmaceuticals, hormonal treatment, interferon, enzymes). • Analyze the ethics in using genetic engineering in healthcare maintenance and treatment. • Analyze a possible career path in genetic engineering.	Analyze a hospital or lab department research. Select a possible career path in genetic engineering and communicate with a company or individual involved in that career path.
See Resource Recovery For Related Information			

Medical Technology

Definition: The application of health care theories to develop methods, products and tools to maintain or improve homeostasis.

Rationale: The study of medical technology will help students maintain and improve homeostasis through the use of technology, become educated consumers, and develop career awareness.

PA Standards		Content	Activity

3.3.4 A
3.3.4 C
3.3.4 D
3.4.4 A
3.6.4 A
3.7.4 B
3.2.4 A
3.1.4 A
3.1.4 B
3.8.4 A
		Understand the maintenance of living organisms.
		• Understand prevention in the maintenance of living organisms.
		  • What immunization is and why we immunize.
		  • Importance of cleanliness
		  • Health monitoring (eyes, height, weight, doctor check-ups and instruments, protective devices)
		• Understand diagnosis in the maintenance of living organisms.
		  • Chemical test (i.e. pH and glucose testing.)
		  • Fluid and tissue tests
		  • Imaging technology (X-rays, ultra sounds)
		• Understand treatment in the maintenance of living organisms.
		  • Pharmaceuticals (over-the-counter, prescriptions, home remedies)
		  • Physical therapy
		• Explore careers in the maintenance of living organisms.
			Construct a stethoscope.
			Invite the school nurse to visit and give a demonstration.
			Invite an Emergency Medical Technician to give a presentation about accidents with and without protective devices.
			Understand concepts behind pill design.
			Identify medicines from nature.

3.3.4 D
3.4.4 A
3.4.4 B
3.6.4 A
3.6.4 B
3.7.4 A
		Understand improving living organisms
		• Understand internal factors that improve living organisms.
		  • Chemicals
		  • Exercise
		  • Invasive (skin penetrating methods)
		• Understand external factors that improve living organisms.
		  • Permanent assistive devices
		  • Orthopedic devices
		  • Assistive technology (casts, finger splints, braces, thermal, chemical)
		• Explore careers in the improvement of living organisms.
			Simulate physically challenged scenarios.
			Explain how an Insect sting treatment device works.
			Conduct a career search.

3.3.4 A 3.6.4 A		Understand the advancement of living organisms • Understand internal factors that contribute to the advancement of	

3.7.4 A 3.7.4 C 3.7.4 D		living organisms that relate to medical technologies that extend the envelope of human performance, experience and health. • Diet • Experimental drugs • Surgery (laser eye surgery, bio feedback) • Understand external factors that contribute to the advancement of living organisms that relate to medical technologies that extend the envelope of human performance, experience and health. • Environmental (space, water) • Mechanical (night vision goggles)	
		Begin Grade 7	
3.3.7 A 3.4.7 C 3.6.7 A 3.6.7 A 3.7.7 C		Explain the maintenance of living organisms. • Explain prevention in the maintenance of living organisms. • Identify immunizations and their methods of delivery. • Cleanliness (effects of personal hygiene, communicable versus non-communicable diseases.) • Health monitoring (frequency requirements, establishing baselines) • Selection of proper protective devices (sports related, transportation related) • Explain diagnosis in the maintenance of living organisms. • Chemical test (instrumentation) • Fluid and tissue tests • Imaging technology (CAT scans, MRI) • Explain treatment in the maintenance of living organisms. • Pharmaceuticals (over-the-counter, prescriptions, home remedies) • Physical therapy (machines, apparatus) • Nutrition (food additives) • Explore careers in the maintenance of living organisms.	Build a heart model.
3.6.7 A 3.6.7 B 3.6.7 C 3.7.7 A 3.7.7 B 3.7.7 C 3.7.7 D 3.2.7 A 3.2.7 B		• Explain internal factors that improve living organisms. • Chemicals (steroids, growth enhancers) • Exercise (recreational, professional) • Invasive (pacemakers, automatic medication dispensers) • Explain external factors that improve living organisms. • Permanent assistive devices (orthopedic devices, assistive technology) • Temporary assistive devices (mechanical, thermal, chemical) • Explore careers in the improvement of living organisms with an emphasis on educational requirements, advancement, opportunities	Construct/analyze skeleton models. Design and build an immobolizer for an animal. Research one medical technology occupation. Give an oral presentation with at least one visual.

		and job availability.	

3.3.7 A
3.6.7 A
3.6.7 B
3.7.7 A
3.7.7 B
3.7.7 C
3.7.7 D
3.2.7 A
3.2.7 B
3.2.7 C
3.1.7 A
3.1.7 B
3.1.7 C
3.1.7 D
3.8.7 A
3.8.7 B
3.8.7 C
		• Explain factors that contribute to the advancement of living organisms
		• Explain internal factors that contribute to the advancement of living organisms that relate to medical technologies that extend the envelope of human performance, experience and health.
		  • Diet, experimental drugs, surgery
		  • Bio feedback (sensors, monitoring devices)
		  • Ethical considerations (organ harvesting, cloning, growing body parts)
		  • Predictions of future developments
		• Explain external factors that contribute to the advancement of living organisms that relate to medical technologies that extend the envelope of human performance, experience and health.
		  • Environmental (space travel and space stations)
		  • Mechanical (virtual reality training devices)
		  • Predictions of future developments
			Student design problem - U.V. alert device
			Hold a debate on the pros and cons of a specific medical technology.

Begin Grade 10			

3.4.10 C
3.6.10 A
3.6.10 B
3.6.10 C
3.7.10 A
3.7.10 B
3.7.10 D
3.2.10 A
3.2.10 B
3.2.10 C
3.1.10 B
3.1.10 D
3.8.10 A
3.8.10 B
3.8.10 C
		Describe the maintenance of living organisms.
		• Distinguish prevention in the maintenance of living organisms.
		  • Identify immunization delivery tools and testing anti-body response.
		  • Health monitoring devices
		  • Data collection and interpretation
		  • Application of appropriate cleanliness materials (best materials for counter tops so germs cannot penetrate)
		  • Design of preventative devices
		• Describe diagnosis in the maintenance of living organisms.
		  • Design and development of instrumentation
		  • Fluid and tissue tests
		  • Imaging technology (florescence bronchoscope, mammography)
		• Identify new treatment technologies in the maintenance of living organisms.
		  • Hormones
		  • Enzymes
		  • Nutrition
		  • Organ transplants
		  • Physical therapy (design and development of machines and
			Student design problem – Insect bite prevention
			Electronic stethoscope construction

		apparatus) • Explore careers in the maintenance of living organisms.	

3.3.10 D
3.4.10 B
3.6.10 A
3.6.10 C
3.7.10 A
3.2.10 A
3.2.10 B
3.2.10 C
3.1.10 A
3.1.10 B
3.8.10 B
3.8.10 C
		Describe factors that improve living organisms
		• Identify internal factors that improve living organisms.
		  • Chemicals (steroids, growth enhancers)
		  • Exercise (recreational, professional)
		  • Invasive (pacemakers, automatic medication dispensers)
		• Identify external factors that improve living organisms.
		  • Permanent assistive devices (orthopedic devices, assistive technology)
		  • Temporary assistive devices (mechanical, thermal, chemical)
		• Explore careers in the improvement of living organisms with an emphasis on educational requirements, advancement opportunities and job availability.
			Model a JarVic Heart.
			Design and build a device for a mobility-challenged person.
			Build an ice and swelling device.
			Develop a human data chart.

3.3.10 D
3.4.10 C
3.6.10 A
3.6.10 C
3.7.10 A
3.7.10 B
3.7.10 D
3.2.10 A
3.2.10 B
3.2.10 C
3.1.10 A
3.1.10 B
3.8.10 A
3.8.10 B
3.8.10 C
		Demonstrate factors that contribute to the advancement of living organisms.
		• Describe factors that contribute to internal factors that advance living organisms, relating to medical technologies that extend the envelope of human performance, experience and health.
		  • Diet, experimental drugs, surgery
		  • Bio-feedback (sensors, monitoring devices)
		  • Ethical considerations (organ harvesting, cloning, growing body parts)
		  • Predictions of future developments
		• Describe external factors that contribute to the advancement of living organisms that relate to medical technologies that extend the envelope of human performance, experience and health.
		  • Environmental (space travel and space stations)
		  • Mechanical (virtual reality training devices)
		  • Predictions of future developments	

Begin Grade 12			

3.4.12 C
3.6.12 A
3.7.12 A
3.7.12 B
3.7.12 D
3.2.12 A
3.2.12 B
3.2.12 C
		Assess the maintenance of living organisms.
		• Analyze the effectiveness of prevention in the maintenance of living organisms.
		  • Immunization research and development
		  • Design, development and application of multiple data collection and health monitoring devices
		  • Technological advancements (daily home monitoring via computer to doctor's office to adjust medication)	

3.1.12 A 3.1.12 B 3.1.12 C 3.1.12 D 3.8.12 A 3.8.12 C		• Cost benefit analysis and sustainability in developing aseptic techniques • Analyze diagnosis in the maintenance of living organisms. • Imaging technology • Assess new treatment technologies in the maintenance of living organisms. • Impacts of technological developments on health • Explore careers in the maintenance of living organisms.	
3.6.12 A 3.6.12 B 3.6.12 C 3.7.12 A 3.7.12 B 3.7.12 D 3.2.12 A 3.2.12 B 3.2.12 C 3.1.12 A 3.1.12 B 3.1.12 C 3.8.12 A 3.8.12 B 3.8.12 C		Analyze factors that improve living organisms. • Assess internal factors that improve living organisms. • Chemicals (development of steroids, growth enhancers) • Impacts of exercise (recreational, professional) • Invasive (transplants and implants) • Assess external factors that improve living organisms. • Permanent assistive device design (orthopedic devices, Prosthetics) • Temporary assistive device design (mechanical, thermal, chemical) • Impacts of technological developments on health that improve living organisms • Alternative medicine that improves living organisms • Acupressure/acupuncture • Holistic healing • Explore careers in the improvement of living organisms with an emphasis on educational requirements, advancement opportunities and job availability.	Design and model machine tool jigs for the physically challenged. Prosthesis development activity
3.3.12 A 3.4.12 C 3.6.12 A 3.6.12 B 3.6.12 C 3.7.12 A 3.7.12 B 3.7.12 D 3.2.12 A 3.2.12 B 3.2.12 C 3.1.12 A 3.1.12 B		Assess factors that contribute to the advancement of living Organisms. • Analyze contributing internal factors that advance living organisms, relating to medical technologies that extend the envelope of human performance, experience and health. • Diet supplements • Experimental drugs • Design and development of surgical instruments • Bio-feedback (sensors, monitoring devices) • Ethical considerations (organ harvesting, cryogenics, growing body parts) • Predictions of future developments • Analyze external factors that contribute to the advancement of living	Student design problem – U.V. alert device

3.1.12 C 3.8.12 A 3.8.12 B 3.8.12 C		organisms that relate to medical technologies that extend the envelope of human performance, experience, and health. • Environmental (space travel and space stations) • Mechanical, electrical and electronic • Predictions of future developments • Assess the impacts of technological developments on health that advance living organisms.	

Regulations and Safety

Definition: Regulations and safety are necessary components of biotechnology in that they ensure a safe and accountable environment for making or modifying products or services for specific uses.

Rationale: Biotechnology will be the fastest growing field in the world during the early part of the 21st century. Its growth must be controlled and effectively managed in order to ensure a safe and productive evolution of processes and products.

PA Standards		Content	Activity
3.8.4 C		Understand public policy development. • Societal issues • Economical issues	Need for regulations for the classroom: Discuss the cause and effect of public policy. Discuss the need for standards.
3.6.4 A 3.2.4 A 3.2.4 B		Understand the process of design and testing. • Contaminate level • Sterility level regulation • Hazardous materials	Frozen Exploding Pop Bottle Activity Store Bought vs. Home Made **BLA#43**
3.6.4 A 3.2.4 A 3.2.4 B		Understand biological and chemical safety. • Poisons • Carcinogens • Hazardous materials • Personal safety	Identification of poisons It's Not All White Activity Household Hazardous Waste Wheel Activity Mr. Yuck Activity Investigate positive and negative living things in air and water.
3.6.4 A 3.8.4 A		Understand basic environmental considerations. • Guidelines • Monitoring • Future planning • Technology effectiveness	Adopt Fauna and Flora Activity Lake Benjamin **BLA#77**
3.6.4 A		Know health and safety protection. • Safe operation of tools, equipment and processes	Personal/home fire safety Fire Safety House Learn Not To Burn Level 2 (Grades 3-5, National Fire Protection Association) Sparky the Dog NFPA Program Development of fire drills and escape routes Wellness – Smoking
3.5.4 A		Understand basic ergonomics.	Automobile Safety, The Flying Egg Activity

3.6.4 A 3.9.4 B		• Protection devices • Physical enhancement • Personal health application	Helmet/bicycle safety Safety equipment for sports Pulling the Pulley Activity
3.5.4 A 3.9.4 A		Know about patents and licensing. • Regulations • Processes • Invention development and enhancement	
		Begin Grade 7	
3.5.7 A 3.9.7 C		Explain basic public policy development. • Societal issues • Political issues • Economical issues	Community utility codes Introduce Occupational Safety and Health Administration, National Fire Protection Association, Environmental Protection Agency and the American National Standards Administration.
3.5.7 A 3.5.7 C		Explain the process of design and testing. • Containment level • Sterility level • Product testing and labeling • Container regulations/recycling	Moldy Stuff Activity Identify and classify preservation methods. Safety labeling Is Your Equipment Safe? Activity *Recycled container uses* *Health regulations and safety inspections*
3.5.7.A 3.5.7.C 3.7.7 A 3.7.7 B		Identify biological and chemical safety. • Poisons • Carcinogens • Mutagens/Tetrogens, • Hazardous materials • Individual and community implications	Fertilizer Plant growth chart. Identify microscopic organisms and their role in the environment. Identify hazardous and non-hazardous microorganisms and chemicals. Transmission of contamination. Identify hazardous materials used in the home.
3.5.7 A 3.9.7 A		Explain basic environmental considerations. • Guidelines • Monitoring • Future planning • Technology effectiveness	Waterway pollution Retrieval of oil products. Lake Benjamin **BLA#77**
3.5.7 A 3.7.7 A		Identify health and safety protection. • Safe operation of tools, equipment and processes	Hand tool safety. Product development. Learn Not To Burn Level 3 (Grades 6-8, National Fire Protection Association) Electrical safety Wired to the max activity

3.6.7 A 3.6.7 C 3.7.7 A 3.7.7 B 3.8.7 B		Explain basic Ergonomics • Protection • Physical enhancement • Personal health application	Individuals with disabilities, adaptive methods
3.6.7 A 3.8.7 B		Identify basic patents and licensing procedures • Regulations • Processes • Invention development and enhancement	Technological evolutions
Begin Grade 10			
3.6.10 A 3.6.10 C		Explain public policy development. • Societal issues • Political issues • Economical issues	Agencies and authorities Recycling waste products Mandatory automobile seat belt laws
3.6.10 A 3.6.10 C 3.2.10 A 3.2.10 B		Describe the process of design and testing. • Containment level • Sterility level • Regulation • Product testing and labeling • Container regulations and recycling	Mining policies Appropriate preservation methods Child proof containers for medicine Design a safer rat trap.
3.6.10 A 3.6.10 C 3.2.10 A 3.2.10 B		Describe biological and chemical safety. • Poisons • Carcinogens • Mutagens/Tetrogens • Hazardous materials • Individual and community implications	Product testing Product safety Effects of contamination over time
3.6.10 A 3.8.10 A		Explain environmental issues concerning regulations and safety • Guidelines • Monitoring • Future planning • Technology effectiveness	Air pollution
3.6.10 A 3.7.10 A		Describe health and safety protection. • Safe operation of tools, equipment and processes	Power tool safety. Chemical safety/air pollution.
3.6.10 A 3.7.10 A 3.7.10 B 3.8.10 B		Explain ergonomics. • Protection • Physical enhancement • Personal application	Human adaptive systems. Developing human data
3.6.10 A 3.8.10 B		Describe patents and licensing. • Regulations	Patent application

		• Processes • Invention development and enhancement	
Begin Grade 12			
3.8.12 C		Analyze public policy development. • Societal issues • Political issues • Economical issues	National laws and agencies affecting biotechnology Develop criteria for evaluating a high school based recycling program.
3.6.12 A 3.2.12 A 3.2.12 B		Assess the process of design and testing. • Containment level • Sterility level • Regulation	Analyze social impacts of existing and proposed levels of contamination and generate solutions. Nuclear Reactor **BLA#78**
3.6.12 A 3.2.12 A 3.2.12 B		Assess biological and chemical safety. • Poisons, • Carcinogens • Mutagens/Tetrogens • Hazardous materials • Individual and community implications	Analyze and redesign hazardous material placards. Analyze and redesign chemical waste policies. Analyze and redesign chemical application.
3.6.12 A 3.8.12 A		Analyze and propose solutions to environmental issues. • Guidelines • Monitoring • Future planning • Technology effectiveness	
3.6.12 A		Assess health and safety protection. • Safe operation of tools, equipment and processes	System and laboratory safety
3.6.12 A 3.7.12 A 3.8.12 B		Analyze and assess ergonomics. • Protection • Physical enhancement • Personal application	Physical enhancement systems
3.6.12 A 3.8.12 B		Assess patents and licensing. • Regulations • Processes • Invention development and enhancement	Review patent protection policies as they relate to biotechnology patents. Energy and Environmental Relationships **BLA#82**

Resource Recovery

Definition: The process of controlling any material given up, discarded or simply not needed by society.

Rationale: Students understand the importance of the recovery and conservation of existing resources and reduction of the waste stream.

PA Standards		Content	Activity

3.8.4 A
3.8.4 B
3.6.4 A
	4.2.4 B
	4.2.4 B
	4.3.4 C
	4.2.7 C
	4.3.4 B
		Identify major types of waste, their origins and treatment.
		• Types
		  • Solids
		  • Sewage
		  • Hazardous byproducts
		• Origins
		  • Naturally occurring
		  • Human byproducts
		  • Municipal waste
		  • Industrial waste
		• Treatment
		  • Burn
		  • Bury
		  • Recycle
		  • Purification
			Classify types of waste.
			Distinguish between
			  • Naturally occurring,
			  • Human byproducts,
			  • Municipal waste,
			  • Industrial waste.
			Clean Water activity from Classroom Connections

3.8.4 C
3.6.4.A
	4.3.4 B
	4.8.4 C
	
	4.2.4 A
	4.2.4 B
	4.3.4 B
		Recognition of major impacts of waste
		• Environmental
		  • Air
		  • Water
		  • Land
		  • Organisms
		• Individual
		  • Health – positive & negative
			Make a new product out of recycled waste.

		Understand resource recovery and conservation. • Recognize types of waste (solid, sewage, hazardous byproducts). • Know where waste comes from (naturally occurring, human byproducts, municipal, industrial). • Recognize environmental effects of waste on air, water, land, and organisms. • Know and identify treatment methods of waste (burn, bury, recycle, purify). • Gain knowledge of positive and negative impacts of waste.	Search for and collect trash around the classroom and classify. Soil treatment activity Water purification activity
		Begin Grade 7	

3.8.7 A
3.6.7.A
3.6.7.C
3.8.7.B
3.8.7.C
3.1.7 A
3.1.7 B
	4.3.7 B
	4.8.7 C
	4.2.7 D
	
	4.3.7 A
		Explain how major types of waste are produced, how they are classified and treated.
		• Types
		  • Solids
		  • Sewage
		  • Hazardous byproducts
		  • Gas
		
		• Classification of hazardous waste
		  • Residential
		  • Industrial
		  • Infectious
		  • Radioactive
		• Treatment
		  • Burn
		  • Bury
		  • Recycle
		  • Alternative methods of waste treatment
			Discuss the digestion process.
			Farm food chain
			Farmer grows crops, feeds excess to cows and manure is spread on the fields.
			Diagram an incinerator, landfill and recycling plant.

3.6.7 A 3.6.7 C 3.8.7 B 3.8.7 C	4.3.7 A 4.3.7 B 4.3.7 C 4.8.7 D	Explain the positive and negative impacts of waste. • Individual • Societal • Global	Alternative resources – plastic, wood, packaging Design new products from recycled material.

		Explain resource recovery and conservation. • Explain types of recovery methods associated with solids, sewage, hazardous byproducts and gas. • Explain how genetic engineering is used in the treatment methods of resource recovery (bury, recycle). • Explain the positive and negative impacts of using genetic engineering resource recovery and conservation on an individual, societal and global scale. Identify careers associated with genetic engineering in resource recovery and conservation.	
Begin Grade 10			

3.1.10 A
3.1.10 B
3.1.10 C
3.1.10 D
3.6.10 A
3.6.10 C
	4.2.10 B
	4.2.10 C
	4.2.10 D
	4.3.10 C
	4.8.10 B
	4.8.10 D
		Analyze major types of waste and produce solutions for reduction.
		• Types
		  • Solids
		  • Paper
		  • Glass
		  • Plastic
		  • Metal
		  • Organic
		  • Sewage
		  • Residential
		  • Industrial
		  • Hazardous byproducts
		  • Gas
		• Reduction methods
		  • Decrease source
		  • Reusing
		  • Recycling
		  • Rethinking	

	4.2.10 A 4.2.10 B 4.2.10 C 4.2.10 D 4.3.10 A 4.3.10 B 4.3.10 C	Assess positive and negative economic impacts of waste. • Individual • Societal • Global	

		Understand and apply resource recovery and conservation methods. • Assess methods used to conserve resources by reducing the amounts of waste produced with genetically engineered materials (reduction, reusing, recycling). • Assess "Solid Waste Stream" breakdown using genetically engineered materials (paper, glass, plastic, metal, organic). • Assess the treatment of residential and industrial sewage using genetically engineered materials. • Assess the treatment of hazardous waste using genetically engineered materials (radioactive, infectious, residential, industrial). • Assess the positive and negative economic impacts of using genetically engineered materials in resource recovery and conservation on an individual, societal and global scale. Assess various career paths and/or businesses associated with genetic engineering in resource recovery and conservation.	Research various career paths and/or businesses associated with genetic engineering in resource recovery and conservation.
Begin Grade 12			

3.5.12 D
3.1.12 A
3.1.12 B
	4.2.12 A
	4.3.12 A
		Analyze the handling and treatment of the major types of waste.
		• Transportation
		  • Land
		  • Sea
		  • Air
		  • Space
		• Treatment
		  • Recycling plants
		  • Landfills
		  • Sewage treatment plants
		  • Hazardous waste facilities	

3.8.12 A 3.8.12 B 3.8.12 C	4.2.12 A 4.2.12 B 4.2.12 C 4.2.12 D 4.3.12 A 4.3.12 B 4.3.12 C 4.4.12 B 4.8.12 C	Analyze positive and negative impacts of handling waste. • Individual • Societal • Global	

		Understand and apply genetically engineered materials in resource recovery and conservation. • Analyze genetically engineered materials used in resource recovery handling systems (recycling plants, landfills, sewage treatment plants, hazardous waste facilities). • Analyze the positive and negative impacts of using genetically engineered materials in resource recovery and conservation on an individual, societal and global scale. Analyze a possible career path in genetic engineering.	Select a possible career path in genetic engineering and communicate with a company or individual involved in that career path.

Integration Framework

The following pages represent an attempt to identify the themes/ideas common to the three subject strands (Agriculture, Science and Technology Education) for each of the content areas at specific grade levels (4, 7, 10 & 12). In many cases the language is exact, in other cases the concept is the same but the language is different to reflect the approach taken by the subject area.

This document was developed in an attempt to demonstrate possible areas of integration between the three subject strands. It is not important who teaches Biotechnology to our students. What is important is that Biotechnology is taught. This integration information was developed in an attempt to assist local school districts in meeting the Pennsylvania Academic Standards for Science and Technology and Environment and Ecology by presenting possible delivery strategies that can be employed or adapted to ones that are already being employed, to meet the Biotechnology standard statement and content of these standards. As the need to improve our instructional time increases, the need to eliminate duplication of instruction also increases. This document was developed in an attempt to assist in identifying potential common areas that could be approached through integration to eliminate duplication while increasing the level understanding.

Biotechnology
Common Themes

Agriculture

Grade	Agriculture	Science	Technology Education
4	Importance of agriculture to meet human needs Agricultural influences ▪ Food ▪ Clothing ▪ Shelter ▪ Space Careers	Importance of agriculture to meet human needs Agricultural influences on food, clothing, shelter and space ▪ Food ▪ Clothing ▪ Shelter ▪ Space ▪ Careers	Importance of agriculture to meet human needs Agricultural influences on food, clothing, shelter and space ▪ Food ▪ Clothing ▪ Shelter ▪ Space ▪ Careers
7	Use of human altered and natural resources in agriculture ▪ Biochemical related technology ▪ Quality of life and standard of living ▪ Agricultural and technological Careers	Use of human altered and natural resources in agriculture ▪ Biochemical related technology ▪ Quality of life and standard of living ▪ Agricultural and technological Careers	Use of human altered and natural resources in agriculture ▪ Biochemical related technology ▪ Quality of life and standard of living ▪ Agricultural and technological Careers

10	Applications and impacts of agriculture ▪ Natural resources Impacts of natural cycles Careers	Applications and impacts of agriculture ▪ Natural resources Impacts of natural cycles Careers	Applications and impacts of agriculture ▪ Natural and human altered resources Careers
12	Emerging technologies ▪ Biochemical structure/technologies ▪ Pest management Biochemical application and impacts ▪ Research and development Careers	Emerging technologies ▪ Biochemical structure/technologies ▪ Pest management Careers	Emerging technologies ▪ Biochemical structure/technologies ▪ Pest management Analyze and evaluate impacts Careers

Biotechnology
Common Themes

Biomaterials

Grade	Agriculture	Science	Technology Education
4	Identification of natural and human altered products and their parts Identify how humans use resources to satisfy specific human needs Identify impacts and social implications Food and fiber originate from plants and animals ▪ Techniques of food production and preservation Careers	Identification of natural and human altered products and their parts Identify how humans use resources to satisfy specific human needs Identify impacts and social implications Food and fiber originate from plants and animals Careers	Identification of natural and human altered products and their parts. Identify how humans use resources to satisfy specific human needs Identify impacts and social implications Food and fiber originate from plants and animals Careers
7	Food and fiber originate from plants and animals Explain the impacts and social implications. Careers	Food and fiber originate from plants and animals Explain the impacts and social implications. Careers	Food and fiber originate from plants and animals Explain the impacts and social implications. Careers

10	Modified biomaterials ▪ Application and development of genetically modified organisms/biomaterials ▪ Research & development Careers	Modified biomaterials ▪ Applications ▪ Chemical and biological Careers	Modified biomaterials ▪ Process and application, and utilization of using GMOs (genetically modified organisms) ▪ Compare, contrast and assess Careers
12	Importance of biomaterials to society Careers	Importance of biomaterials to society ▪ Compare, contrast and analyze environmental impacts locally and globally Careers	Importance of biomaterials to society ▪ Compare, contrast and analyze the impacts on individuals, society and the environment ▪ Assess the impact of traditional and biomaterial products on individuals, society and environment. Careers

Biotechnology
Common Themes

Genetic Engineering

Grade	Agriculture	Science	Technology Education
4	Cells/inherited traits ▪ Alike and different ▪ Identify people's basic needs ▪ Increase in food product variety and availability ▪ Development of commercial products	Cells/inherited traits ▪ Alike and different	Cells/inherited traits ▪ Alike and different ▪ Identify people's basic needs ▪ Food and fiber originate from plants and animals
7	Identify the ability to change or enhance genetic characteristics Applications of genetic engineering ▪ Food and fiber production issues ▪ Applications in medicine and law enforcement Ethical considerations, laws and regulations governing genetic engineering Careers	Identify the ability to change or enhance genetic characteristics Applications of genetic engineering ▪ Food and fiber production ▪ Medical Applications ▪ Forensics Ethical considerations, laws and regulations governing genetic engineering Careers	Identify the ability to change or enhance genetic characteristics Applications of genetic engineering Ethical considerations, laws and regulations governing genetic engineering Careers

10	Methods and techniques used in genetic engineering Local, state and national issues/laws associated with genetically engineered materials/organisms Careers	Methods and techniques used in genetic engineering Local, state and national issues/laws associated with genetically engineered materials/organisms Careers	Methods and techniques used in genetic engineering Local, state and national issues/laws associated with genetically engineered materials/organisms Careers
12	Applications and impacts of genetic engineering ▪ Advanced methods and techniques used in genetic engineering Careers	Applications and impacts of genetic engineering ▪ Advanced methods and techniques used in genetic engineering Careers	Applications and impacts of genetic engineering ▪ Advanced methods and techniques used in genetic engineering Careers

Biotechnology
Common Themes

Medical Technology

Grade	Agriculture	Science	Technology Education
4	Understand the maintenance of living organisms.	Understand the maintenance of living organisms. ▪ Diagnosis	Understand the maintenance of living organisms. ▪ Diagnosis
7	Maintenance and improvement of living organisms ▪ Impacts of medical advancements on society. ▪ Production systems	Maintenance of living organisms ▪ Models in anatomy and physiology systems ▪ Enzyme functions	Maintenance and improvement of living organisms ▪ Prevention, diagnosis and treatment ▪ Internal factors
10	Maintenance of living organisms. ▪ Human vs. animal biotechnology	Maintenance and improvement of living organisms. ▪ Consideration of ethical development and application of medical techniques ▪ Antibody/enzyme specificity	Maintenance and improvement of living organisms. ▪ Monitoring ▪ Treatment ▪ Assistive devices
12	Maintenance, improvement and advancement of living organisms.	Maintenance, improvement and advancement of living organisms. ▪ ethical developments ▪ immunity ▪ enzyme activity ▪ genetic engineering	Maintenance, improvement and advancement of living organisms. ▪ prevention, diagnosis and treatment ▪ internal & external factors

Biotechnology
Common Themes

Regulations and Safety

Grade	Agriculture	Science	Technology Education
4	Environmental issues ▪ Laws and regulations ▪ Hygiene	Environmental monitoring. ▪ Living conditions ▪ Hygiene ▪ Contamination	Environment ▪ Guidelines ▪ Monitoring ▪ Future planning ▪ Effectiveness of technology
7	Safety ▪ Laws and regulations to protect the environment	Safety ▪ Pathogen spread/prevention ▪ Processing design & testing ▪ Location/impact & prevention of pathogens in the environment	Safety ▪ Design and testing ▪ Biological and chemical ▪ Protection
10	Safety in industry ▪ Regulations	Aseptic techniques and safety standards ▪ In industry ▪ Community	Safety in the community and in industry ▪ Regulations ▪ Implications ▪ Protection ▪ Tools and processes
12	Biotechnology as it relates to health and well being ▪ Regulations ▪ Product design and development	Biotechnology techniques in promoting health and well being ▪ Regulations ▪ Evaluation of products	Biotechnology as it relates to health and well being ▪ Regulations, patents and public policy ▪ Design development and testing ▪ Safety

Biotechnology
Common Themes

Resource Recovery

Grade	Agriculture	Science	Technology Education
4	Origins of waste ▪ End product from manufacturing Impacts	Origins of waste Impacts ▪ Effects on life cycles	Origins of waste ▪ Types and treatment Impacts ▪ Environmental ▪ Individual
7	Negative impacts of waste on the environment. ▪ Results of manufacturing	Positive and negative impacts of waste ▪ The environment ▪ The design process ▪ Management of waste	Positive and negative impacts of waste ▪ Individual ▪ Society ▪ Global
10	Solutions to commercial applications ▪ Waste reduction ▪ Pollution	Waste treatment ▪ Natural organisms	Solutions for waste reduction ▪ Decrease source ▪ Reusing ▪ Recycling ▪ Rethinking
12	Handling and treatment of waste ▪ Engineered products	Analyze the handling and treatment of major types of waste. ▪ Recycling ▪ Remediation	Analyze the handling and treatment of major types of waste. ▪ Transportation of waste ▪ Treatment

Biotechnology
Resources, References and Web Sites

Cornell Composting in Schools, "Detailed Study of Compost Organism"
www.cfe.cornell.edu/compost/advanced/microbes/htm

"Worm Composting" Project Seasons "Wiggle Worms"
Province of New Brunswick, P. O. Box 6000, Fredericton, N.B. Canada, e3b5h1

Pollination Activity: www.bio-rad.com Biotechnology Explorer: Secrets of the Rain Forest

Practical Biotechnology

Access Excellence web page

Your World/Our World, Vol 7 #1 "Strong Bones/Weak Bones," PA Biotech Association
1524 W. College Ave.
Suite 206, State College, PA 16801

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3. Applications of Biotechnology in Aquaculture, National Council for Agricultural Education

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14. Agricultural Biotechnology: Insect Control Benefits, Leonard P. Gianessi, Janet Carpenter, National Center for Food and Agricultural Policy, 1616 P Street, NW, First Floor, Washington D.C., 20036, 202-328-5048

15. Haccp Food Safety Manual, Joan K. Loken

16. Pests Have Enemies Too: Teaching Young Scientists About Biological Control, Jeffords, M.R. and A.S. Hodgins, Illinois Natural History Survey Special Publication 18. Pp64

17. National Council for Agricultural Education, Biotechnology Curriculum

18. National Council for Agricultural Education New and Emerging Technologies Curriculum

19. Using Genomics in Plant Genetics Research, Pioneer Hi-bred International, Inc., Des Moines, IA, 1999

20. Applied Environmental Science, National Council for Agricultural Education

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22. The Science of Agriculture-A Biological Approach, Ray V. Herren, Delmar Publishers, 3 Columbia Circle, Box 15015, Albany, NY, 12212-5015, copyright 2002, 800-347-7707

23. Modern Livestock & Poultry Production, James R. Gillespie, Delmar Publishers, 3 Columbia Circle, Box 15015, Albany, NY, 12212-5015, copyright 2002, 800-347-7707

Biotechnology Advisory Team Members

Pennsylvania Department of Education Leadership Team

Dr. G. Kip Bollinger	Pennsylvania Department of Education	Science Education Advisor
Mr. Robert Dorn	Pennsylvania Department of Education	Technology Education Advisor
Mr. Timothy Weller	Pennsylvania Department of Education	Agriculture Education Advisor
Ms. Kim Rivera	Indiana University Intern	
Mr. Michael D. Plyler	Edinboro University Intern	
Mr. John Benson	East Stroudsburg University Intern	

Agriculture Advisory Team

Dr. Lynn Brown	Pennsylvania State University	Associate Professor Food Science
Mr. Richard Cook	Northern High School	
Mr. Mark Dietrich	Upper Dauphin Area High School	
Ms. Lori Dodson	North Montco Technical Career Center	
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Ms. Marcia Paterson	Milton Hershey School District	
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Science Advisory Team

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Dr. Kathleen Conn	West Chester School District	Science Department Chair
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Ms. Michele Dubaich	Greenwood High School	Science Chair
Dr. John Enders	Pennsylvania Biotechnology Association	Executive Director, Pennsylvania Biotechnology
Ms. Jane Konrad	University of Pittsburgh	
Ms. Valerie Kopenhaver	Susquehanna Township High School	Science Teacher
Dr. William Metz	Pennridge School District	Science Supervisor
Mr. Clint Musser	Boyertown Area High School	Science Teacher
Mr. Bill Ryding	Kane Area School Distrcit	
Ms. Laura Stiles	Susquehannock High School	Chemistry Teacher
Mr. Mark Temons	Muncy High School	
Mr. Bill Wonders	West Creek Hills Elementary School	
Dr. Ed Zielinski	Clarion University	Director, Biotechnology Institute for the Systemic

Technology Advisory Team

Mr. Robert Avril	Hermitage School District	Technology Education Teacher
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Mr. Terry Crissey	Forest Hills School District	Technology Chair
Mr. Wayne Dallas	North Penn School District	Technology Education Teacher
Mr. Edward Frescoln	Tredyffrin-Easton School District	Technology Education Teacher
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Mr. David Hortman	Milton Hershey School	Technology Education Teacher
Ms. Kathy Jones	Lower Dauphin Middle School	
Mr. Ron Lister	Downingtown Area School District	Technology Education Teacher
Mr. Eric Miller	Boyertown Area High School	Technology Education Teacher
Dr. Clair Roudebush	Millersville University	Technology Education
Dr. Ernest Savage	Bowling Green State University	Interim Dean
Ms. Karen Schmidt	Coatesville Area School District	School Board Member
Mr. Robert Shultz	Downingtown Area School District	Biology Teacher
Mr. Jeffrey Testa	North Penn School District	Technology Education Teacher
Ms. Joanne M. Trombley	J.R. Fugett Middle School	Technology Education Teacher
Mr. Jason Valick	Boyertown Area High School	Technology Education Teacher
Mr. Paul Zeroth	Susquehannock High School	Technology Education Teacher