Biotechnology:
Applications in Agriculture

Curriculum Guide: *Biotechnology: Applications in Agriculture*

Unit: I. Introduction to Biotechnology

Unit Objective:

Students will demonstrate an understanding of the foundations of biotechnology by developing a pamphlet or poster and oral presentation describing the history, the use, and the benefits or detriments of a specific genetically manipulated food product.

Show-Me Standards: 3.4, SC8

References:

Biotechnology: Applications in Agriculture. University of Missouri-Columbia, Instructional Materials Laboratory, 1998.

Biotechnology in Food and Agriculture. Food and Agriculture Organization of the United Nations. Accessed August 8, 2003, from http://www.fao.org/BIOTECH/act.asp.

Food Biotech Info. Accessed August 8, 2003, from http://www.foodbiotechinfo.com/index.html.

Food Science and Technology. University of Missouri-Columbia, Instructional Materials Laboratory, 1994.

Genetically Engineered Foods. Mc Vitamins. Accessed March 16, 2004, from http://www.mcvitamins.com/genetically_engineered_foods.htm.

Lambrecht, B. *Dinner at the New Gene Café: How Genetic Engineering Is Changing What We Eat, How We Live, and the Global Politics of Food*, 1st ed., New York: Thomas Dunne Books, 2001.

Rader, C. M. *A Report on Genetically Engineered Crops*. Accessed March 16, 2004, from http://members.tripod.com/c_rader0/gemod.htm.

Science in Your Shopping Cart. U.S. Department of Agriculture. Accessed October 9, 2003, from http://www.ars.usda.gov/is/np/shopcartintro.html.

Winston, M. L. *Travels in the Genetically Modified Zone*. Cambridge, MA: Harvard University Press, 2002.

Students may use additional outside sources to complete this activity.

Instructional Strategies/Activities:

- Students will engage in study questions in lesson 1.
- Students will complete AS 1.1, What Is…? Facts about Biotechnology.
- Additional activities that relate to the unit objective can be found under the heading "Other Activities" in the following location: p. I-5 (1, 2).

Performance-Based Assessment:

Students will work in groups of three to develop a pamphlet or poster designed to describe the history, the use, and the benefits or detriments of a specific genetically manipulated food product. Each team will complete its project with a brief oral presentation to the class regarding its findings.

Assessment will be based on the accuracy, organization, and clarity of the information cited in the pamphlet or poster. Additional consideration will be given to the quality of both the material produced and the oral presentation. Assessment also will take into account grammar, spelling, punctuation, and capitalization.

Unit I—Introduction to Biotechnology
Instructor Guide

The instructor should assign the performance-based assessment activity at the beginning of the unit. Students will work toward completing the activity as they progress through the unit lessons. The assessment activity will be due at the completion of the unit.

1. Students will work in teams of three to focus their efforts on the production of a pamphlet or poster on a genetically manipulated food product.

2. Team members will work as a unit to identify and research an example of a genetically manipulated food product.

3. Students may use material in the unit and additional outside material to complete their presentations. Students may not use the source material word for word and must provide a complete bibliography of their sources along with their presentation.

4. Below is a suggested list of genetically manipulated food products you may want to provide for students to consider. Students may also select another genetically manipulated food product, provided the selection is approved by the instructor.
   - ❑ Milk and other dairy products from cows that are injected with rBGH, a genetically engineered growth hormone
   - ❑ Soybean, tomato, corn, and canola plants that withstand herbicide application
   - ❑ Corn, tomatoes, and potatoes with built-in pesticides
   - ❑ Potatoes, tomatoes, cantaloupe, squash, cucumber, corn, canola, soybeans, and grapes manipulated to resist plant viruses
   - ❑ Peppers and tomatoes engineered to resist plant fungi
   - ❑ Tomatoes, peas, peppers, and tropical fruits manipulated to extend shelf life and improve processing quality
   - ❑ Corn, sunflowers, and soybeans engineered to contain altered levels of nutrients
   - ❑ Canola and peanuts with altered lipid profiles
   - ❑ Coffee beans with altered caffeine content
   - ❑ Potatoes that absorb less oil when fried
   - ❑ Corn and peas engineered for a prolonged shelf life
   - ❑ Various enzymes (proteins that speed up biological processes) used to make various products (e.g., beer, wine, fruit juice, sugar, oil, and baked goods)
   - ❑ Genetically engineered rennet for making cheese

5. After completing the research, the team will use its findings to develop, outline, and write material for a pamphlet or poster.
   a. Information in the pamphlet or poster will serve as the focus for a brief oral presentation on the food product selected for research.
   b. The presentation should be thorough, but concise, and range between 5 and 10 minutes, including time for questions and answers.

6. Information in the oral presentation and in the pamphlet or poster should address the following:
   - ❑ The product's history and its use
   - ❑ How the food product has been genetically manipulated
   - ❑ Why the food product has been genetically manipulated
   - ❑ The implications (pro and con) for the commercial food production industry of the product's genetic manipulation
   - ❑ The benefits or detriments of the genetically manipulated product for the consumer

7. Assessment will evaluate the team's effort (both on the presentation and pamphlet/poster).
   a. Factors to be evaluated will be accuracy, organization, clarity, and quality.
   b. Spelling, grammar, punctuation, and capitalization will be factors in the assessment.

Unit I—Introduction to Biotechnology
Student Handout

1. You will work in teams of three students to focus your efforts on the production of a pamphlet or poster on a genetically manipulated food product.

2. As team members, you will work as a unit to identify and research an example of a genetically manipulated food product.

3. You may use material in the unit and additional outside material to complete your presentation. You may not use the source material word for word and must provide a complete bibliography of your sources along with your presentation.

4. After completing the research, your team will use its findings to develop, outline, and write material for a pamphlet or poster.
   a. Information in the pamphlet or poster will serve as the focus for a brief oral presentation on the food product selected for research.
   b. The presentation should be thorough, but concise, and range between 5 and 10 minutes, including time for questions and answers.

5. Information in your team's oral presentation and in the pamphlet or poster should address the following:
   - ❑ The product's history and its use
   - ❑ How the food product has been genetically manipulated
   - ❑ Why the food product has been genetically manipulated
   - ❑ The implications (pro and con) for the commercial food production industry of the product's genetic manipulation
   - ❑ The benefits or detriments of the genetically manipulated product for the consumer

6. Assessment will evaluate your team's effort (both on the presentation and pamphlet/poster).
   a. Factors to be evaluated will be accuracy, organization, clarity, and quality.
   b. Spelling, grammar, punctuation, and capitalization will be factors in the assessment.

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Unit I—Introduction to Biotechnology
Scoring Guide
Team Topic/Members _____

Assessment Area	Criteria	0 Points	1 Point	2 Points	3 Points	4 Points	Weight	Total
Oral Presentation	❑ Accuracy ❑ Organization ❑ Clarity ❑ Quality	0 criteria met	1 criterion met	2 criteria met	3 criteria met	All 4 criteria met	X 7.5	
Pamphlet or Poster	❑ Accuracy ❑ Organization ❑ Clarity ❑ Quality	0 criteria met	1 criterion met	2 criteria met	3 criteria met	All 4 criteria met	X 15	
Technical Considerations	❑ Spelling ❑ Grammar ❑ Punctuation ❑ Capitalization	0 criteria met	1 criterion met	2 criteria met	3 criteria met	All 4 criteria met	X 2.5	
TOTAL								

Final Assessment Total _____/100 pts.

Comments:

Biotechnology:
Applications in Agriculture

Curriculum Guide: *Biotechnology: Applications in Agriculture*

Unit: II. Issues in Biotechnology

Unit Objective:

Students will demonstrate an understanding of the concerns regarding biotechnology by conducting debates on issues in the field.

Show-Me Standards: 4.1, SC8

References:

Amber Waves. United States Department of Agriculture. Economic Research Service. Accessed October 15, 2003, from http://www.ers.usda.gov/AmberWaves/.

Biotechnology: Applications in Agriculture. University of Missouri-Columbia, Instructional Materials Laboratory, 1998.

Extemporaneous Debate Rules. San Diego State University. Accessed August 8, 2003, from http://www-rohan.sdsu.edu/faculty/dunnweb/debaterules.html.

Faces of Agriculture. Accessed October 15, 2003, from http://www.facesofag.com/.

Loos Tales. Accessed October 15, 2003, from http://www.loostales.com/.

Tomlinson, J. *Argumentation*. Accessed August 8, 2003, from http://facstaff.bloomu.edu/jtomlins/debate_formats.htm.

What is Debate? International Debate Education Association. Accessed December 3, 2003, from http://www.idebate.org/info/whatisdebate.asp.

Students may use additional outside sources to complete this activity.

Instructional Strategies/Activities:

- Students will engage in study questions in lessons 1 through 3.
- Students will complete AS 1.1, Community Survey; and AS 2.1, Solving the Regulatory Puzzle.
- Additional activities that relate to the unit objective can be found under the heading "Other Activities" in the following locations: p. II-4 (3) and p. II-21 (1).

Performance-Based Assessment:

Students will form teams of two to three students to research and debate issues, such as ethical, social, economic, and cultural concerns, in biotechnology.

Assessment will be based on each speaker's effort and will take into consideration the thoroughness, completeness, accuracy, and persuasiveness of the information presented during the debate. Other factors to be assessed will be presentation and timing.

Unit II—Issues in Biotechnology
Instructor Guide

The instructor should assign the performance-based assessment activity at the beginning of the unit. Students will work toward completing the activity as they progress through the unit lessons. The assessment activity will be due at the completion of the unit.

1. Students will work in teams of two or three to research and debate a topic related to an issue of the application of biotechnology.

2. Each team of two or three students will link with a team of similar size to select a single debatable topic for which one team will serve as advocates and the other team will serve as dissenters.

3. The list below is suggested debate topic questions you may want to provide for students to consider. Students may also develop their own questions to debate, provided those questions are based on valid issues in the field of biotechnology, approved by the instructor, and agreed upon by the two teams debating the issue.
   - ❑ Will genetically engineered animals present any health hazards to people?
   - ❑ Is it ethically acceptable to create genetically engineered animals?
   - ❑ Are genetically engineered foods safe to eat?
   - ❑ Will engineered foods be less expensive and/or more nutritious?
   - ❑ Will decisions about the use of biotechnology products include input from those who will be most directly affected?
   - ❑ What is the ethical and moral framework for creating all types of engineered organisms?
   - ❑ How adequate are current regulations for assuring public safety?
   - ❑ How can the public have a direct voice in the risk assessment process?
   - ❑ Will increased knowledge about biotechnology be sufficient to alleviate concerns?
   - ❑ Do television and the press accurately depict biotechnology issues?
   - ❑ What are the legal considerations regarding the application of biotechnology to agriculture?
   - ❑ What are the moral ramifications of the application of biotechnology techniques to agriculture?

4. Once a topic is identified, both teams will agree on subtopics to be researched and debated by each paired advocate and dissenter. NOTE: Members of each pairing of students could conduct research independently or in pairs, depending on the instructor's approach to the assignment. While independent research may afford an element of surprise in the debate, paired research could encourage deeper thought and consideration by the participants as they prepare to debate each other.

5. Students may use material in the unit and additional outside material to complete their research. Students may not use the source material word for word and must provide a complete bibliography of their sources after their debate.

6. After completing research, the teams will square off in a formal debate format roughly organized as follows:
   a. First speaker, advocate: 5 minutes
   b. First speaker, dissenter: 5 minutes
   c. Second speaker, advocate: 5 minutes
   d. Second speaker, dissenter: 5 minutes
   e. Rebuttal, third (or first) speaker, dissenter: 2 minutes
   f. Rebuttal, third (or first) speaker, advocate: 2 minutes

7. To accurately time the presentation of each speaker, you may want to designate an official timekeeper from among the members of the class.

8. Assessment will evaluate each speaker's effort and will take into account the following factors:
   a. Thoroughness: Does the speaker thoroughly cover his or her assigned aspect of the debated issue?
   b. Completeness: How completely does the speaker explain her or his position on the issue?
   c. Accuracy: Does the speaker present accurate factual information?
   d. Persuasiveness: How persuasive is the speaker in winning listeners to his or her side of the debated issue?
   e. Presentation: What is the overall impression conveyed by the speaker during her or his presentation?
   f. Timing: Does the speaker confine his or her presentation to the time allotted?

Unit II—Issues in Biotechnology
Student Handout

1. You will work a team of two or three to research and debate a topic related to an issue of the application of biotechnology.

2. Your team will link with a team of similar size to select a single debatable topic for which one team will serve as advocates and the other team will serve as dissenters.

3. Once a topic is identified, both teams will agree on subtopics to be researched and debated by each paired advocate and dissenter.

4. You may use material in the unit and additional outside material to complete your research. You may not use the source material word for word and must provide a complete bibliography of your sources after your debate.

5. After completing research, the teams will square off in a formal debate format roughly organized as follows:
   a. First speaker, advocate: 5 minutes
   b. First speaker, dissenter: 5 minutes
   c. Second speaker, advocate: 5 minutes
   d. Second speaker, dissenter: 5 minutes
   e. Rebuttal, third (or first) speaker, dissenter: 2 minutes
   f. Rebuttal, third (or first) speaker, advocate: 2 minutes

6. Assessment will evaluate each speaker's effort and will take into account the following factors:
   a. Thoroughness: Does the speaker thoroughly cover his or her assigned aspect of the debated issue?
   b. Completeness: How completely does the speaker explain her or his position on the issue?
   c. Accuracy: Does the speaker present accurate factual information?
   d. Persuasiveness: How persuasive is the speaker in winning listeners to his or her side of the debated issue?
   e. Presentation: What is the overall impression conveyed by the speaker during her or his presentation?
   f. Timing: Does the speaker confine his or her presentation to the time allotted?

Biotechnology: Applications in Agriculture

Unit II—Issues in Biotechnology
Scoring Guide
Debate Topic/Members _____

Assessment Area	Criteria	0 Points	1 Point	2 Points	3 Points	4 Points	Weight	Total
Debate Content and Presentation	Issue covered thoroughly	Failed	Poor	Fair	Good	Excellent	X 5	
	Position explained completely	Failed	Poor	Fair	Good	Excellent	X 5	
	Information is accurate	Failed	Poor	Fair	Good	Excellent	X 5	
	Speaker is persuasive	Failed	Poor	Fair	Good	Excellent	X 5	
	Speaker makes good impression	Failed	Poor	Fair	Good	Excellent	X 2.5	
	Speaker presents within allotted time	Failed	Poor	Fair	Good	Excellent	X 2.5	
TOTAL								

Final Assessment Total _____/100 pts.

Comments:

Biotechnology:
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Curriculum Guide: *Biotechnology: Applications in Agriculture*

Unit: III. Basic Laboratory Skills

Unit Objective:

Students will demonstrate a working understanding of the skills and considerations required to conduct laboratory experiments by creating a proposal for an experiment.

Show-Me Standards: 1.1, SC7

References:

Agriscience Handbook. National FFA Organization. (See an example cover sheet for a research proposal on p. 10.) Accessed March 30, 2004, from http://www.ffa.org/programs/ag_sci/documents/agsci_handbook.pdf.

Biology Lesson Plans (High School). Texas A&M University. Accessed August 11, 2003, from http://www.tamucc.edu/~eduweb/AppliedConnections/HSScience/biology.html.

Biotechnology: Applications in Agriculture. University of Missouri-Columbia, Instructional Materials Laboratory, 1998.

Science Fair Central. Discoveryschool.com. Accessed March 23, 2004, from http://school.discovery.com/sciencefaircentral/.

Science Fair Project on the Web. Accessed March 23, 2004, from http://sciencefairproject.virtualave.net/.

Scifair.org. The Society for Amateur Scientists. Accessed March 23, 2004, from http://www.scifair.org/.

Tutorials With Emphasis on Applicability to High School Chemistry. Chemistrycoach.com. Accessed August 11, 2003, from http://www.chemistrycoach.com/tutorials-9.htm.

Students may use additional outside sources to complete this activity.

Instructional Strategies/Activities:

- Students will engage in study questions in lessons 1 through 3.
- Students will complete AS 1.1, Using the Scientific Method; and AS 3.1, Using a Material Safety Data Sheet (MSDS).
- Additional activities that relate to the unit objective can be found under the heading "Other Activities" in the following locations: p. III-17 (1) and p. III-26 (1).

Performance-Based Assessment:

Students will work in groups of three to develop a written proposal for a scientific experiment. The proposal will include a statement of the problem, a list of materials and equipment, an outline of the procedure, and a list of safety measures to be taken or observed when conducting the lab work. Assessment will be based on the thoroughness, completeness, accuracy, and practicality of the proposed work. Other factors to be assessed will be grammar, spelling, punctuation, and capitalization.

Unit III—Basic Laboratory Skills
Instructor Guide

The instructor should assign the performance-based assessment activity at the beginning of the unit. Students will work toward completing the activity as they progress through the unit lessons. The assessment activity will be due at the completion of the unit.

1. Students will work in teams of three to identify an appropriate subject for a scientific laboratory experiment.

2. Experiment subjects may be derived from any legitimate field of science and do not need to be related to biotechnology. Students may develop their own ideas for an experiment subject, or the teacher may offer suggestions. Examples of practical experiment subjects include, but are not limited, to the following:
   - ❑ Do pH levels vary in different varieties of apples?
   - ❑ Do pH levels vary in different varieties of oranges?
   - ❑ Does the length of exposure to moisture affect popcorn popping rates?
   - ❑ Does the length of exposure to dry conditions affect popcorn popping rates?
   - ❑ Do water levels vary in different varieties of lettuce?
   - ❑ How is the freezing rate of water influenced by the water's initial temperature? For example, does hot water freeze sooner or later than cold water?
   - ❑ What amount and frequency of plant food application yields the largest blooms on a specific variety of rosebush?
   - ❑ Under specified conditions, how much water does a specific variety of houseplant absorb in a week?
   - ❑ How far do bees travel from their hives?
   - ❑ What natural substances kill mosquito larvae?
   - ❑ What are the effects of various temperatures on the behavior of a specific type of insect?
   - ❑ On what type of a surface does a snail move fastest?
   - ❑ How do pet mice respond to different types of food?
   - ❑ What color of bird feeder will attract the most birds?

3. After identifying an appropriate experiment subject, each team will write a proposal describing the design of the experiment.

4. Each team's proposal will include descriptions of the following elements:
   - ❑ A statement of the problem (NOTE: Each team is required to obtain approval of the problem from the teacher before proceeding with the proposal.)
   - ❑ A complete list of materials and equipment required to execute the proposed experiment
   - ❑ A detailed, step-by-step outline of the procedure to be used in conducting the experiment
   - ❑ A complete list of safety measures to be taken or observed when conducting the laboratory experiment

5. Students may use material in the unit and additional outside material to complete their proposals. Students may not use the source material word for word and must provide a complete bibliography of their sources along with their proposals.

6. Assessment will be based on the thoroughness, completeness, accuracy, and practicality of the proposal. Each of the four elements of the proposal will be examined according to those factors. Other factors to be considered in the assessment are grammar, spelling, punctuation, and capitalization.

Unit III—Basic Laboratory Skills
Student Handout

1. You will work in a team of three students to identify an appropriate subject for a scientific laboratory experiment.

2. After identifying an appropriate experiment subject, your team will write a proposal describing the design of the experiment.

3. Your team's proposal will include descriptions of the following elements:
   - ❑ A statement of the problem (NOTE: Your team is required to obtain approval of the problem from the teacher before proceeding with the proposal.)
   - ❑ A complete list of materials and equipment required to execute the proposed experiment
   - ❑ A detailed, step-by-step outline of the procedure to be used in conducting the experiment
   - ❑ A complete list of safety measures to be taken or observed when conducting the laboratory experiment

4. You may use material in the unit and additional outside material to complete the proposal. You may not use the source material word for word and must provide a complete bibliography of your sources along with your proposal.

5. Assessment will be based on the thoroughness, completeness, accuracy, and practicality of your proposal. Each of the four elements of the proposal will be examined according to those factors. Other factors to be considered in the assessment are grammar, spelling, punctuation, and capitalization.

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Unit III—Basic Laboratory Skills
Scoring Guide
Experiment Topic/Team Members _____

Assessment Area	Criteria	0 Points	1 Point	2 Points	3 Points	4 Points	Weight	Total
Statement of Problem	❑ Thorough ❑ Complete ❑ Accurate ❑ Practical	0 criteria met	1 criterion met	2 criteria met	3 criteria met	All 4 criteria met	X 5.625	
List of Materials and Equipment	❑ Thorough ❑ Complete ❑ Accurate ❑ Practical	0 criteria met	1 criterion met	2 criteria met	3 criteria met	All 4 criteria met	X 5.625	
Outline of Procedure	❑ Thorough ❑ Complete ❑ Accurate ❑ Practical	0 criteria met	1 criterion met	2 criteria met	3 criteria met	All 4 criteria met	X 5.625	
List of Safety Measures	❑ Thorough ❑ Complete ❑ Accurate ❑ Practical	0 criteria met	1 criterion met	2 criteria met	3 criteria met	All 4 criteria met	X 5.625	
Technical Considerations	❑ Spelling ❑ Grammar ❑ Punctuation ❑ Capitalization	0 criteria met	1 criterion met	2 criteria met	3 criteria met	All 4 criteria met	X 2.5	
TOTAL								

Final Assessment Total _____/100 pts.

Comments:

Biotechnology:
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Curriculum Guide: *Biotechnology: Applications in Agriculture*

Unit: IV. Foundations of Genetic Engineering

Unit Objective:

Students will demonstrate an understanding of an aspect of genetic engineering by extracting DNA from a plant or animal source and analyzing the results in a written report.

Show-Me Standards: 1.3, SC7

References:

Biotechnology: Applications in Agriculture. University of Missouri-Columbia, Instructional Materials Laboratory, 1998.

DNA Extraction From Kiwi. Office of Biotechnology. Iowa State University. Accessed October 31, 2003, from http://www.biotech.iastate.edu/publications/lab_protocols/DNA_Extraction_Kiwi.html.

DNA Extraction From Onion. Office of Biotechnology. Iowa State University. Accessed October 31, 2003, from http://www.biotech.iastate.edu/publications/lab_protocols/DNA_Extraction_Onion.html.

DNA Extraction From Onion – Teacher Guide "Chemical Version." Biotech Project. University of Arizona. Accessed October 31, 2003, from http://biotech.biology.arizona.edu/labs/DNA_extraction_onion_teach.html.

How to Extract DNA From a Banana. Biology. About, Inc. Accessed October 31, 2003, from http://biology.about.com/c/ht/00/07/How_Extract_DNA_Banana096293248 1.htm.

How to Extract DNA From Anything Living. Genetic Science Learning Center. University of Utah. Accessed July 24, 2003, from http://gslc.genetics.utah.edu/units/activities/extraction/.

Onion DNA Extraction. Solarwind.com. Accessed October 31, 2003, from http://www.solarwinds.com/users/neumann/onion_dna_extraction.htm.

Teacher Guide: What is DNA? DNA Extraction From Kiwifruit. Biotech Project. University of Arizona. Accessed October 31, 2003, from http://biotech.biology.arizona.edu/labs/DNA_Kiwifruit_teacher.html.

Instructional Strategies/Activities:

- Students will engage in study questions in lessons 1 through 3.
- Students will complete AS 1.1, Comparing Plant and Animal Cells; and AS 2.1, Mitosis and Meiosis.
- Additional activities that relate to the unit objective can be found under the heading "Other Activities" in the following locations: p. IV-5 (2) and p. IV-21.

Performance-Based Assessment:

Students will form teams of three to extract DNA from a specific plant or animal material. After completing the process, each team will compare its findings with those of other teams and write a brief summary report of its findings.

Assessment will be based on the application of proper laboratory procedure and technique, team cohesiveness, the time needed to conduct the procedure, the degree of success resulting from the procedure, and conclusions drawn from the comparison of findings.

Unit IV—Foundations of Genetic Engineering
Instructor Guide

The instructor should assign the performance-based assessment activity at the beginning of the unit. Students will work toward completing the activity as they progress through the unit lessons. The assessment activity will be due at the completion of the unit.

1. Students will form teams of three to conduct the procedure to extract DNA material from a plant or animal source.

2. The teacher will provide, or assign responsibility for providing, the following to each team of students:
   - ❑ Organic material (plant or animal sources) to be used as subjects of the DNA extraction procedure (NOTE: To promote diverse results, each team should analyze material from a different source.)
   - ❑ Equipment and material to conduct the procedure
   - ❑ A description or plan for extracting DNA, including maximum time for the procedure (NOTE: The teacher is advised to consult one or more of the web sites listed among the references for this performance-based assessment activity to determine the specific equipment, material, and procedure outline to supply to each team of students.)

3. Each team will conduct the procedure a minimum of twice; if time permits, each member of the team will conduct the procedure to duplicate and verify results.

4. After completing the procedure, each team will rotate through all other team stations and visually compare one of its samples to the one or two samples remaining at each team's station.

5. After completing the rotation through all stations, each team will briefly summarize in a written report the results of its procedure and its findings during the visual comparison of other teams' results. The report should be no more than two short paragraphs.

6. Assessment will be based on the quality of effort for the following factors:
   a. Application of proper procedure and technique during the laboratory exercise
   b. Team cohesiveness (i.e., how well team members worked together)
   c. The time needed to conduct the procedure
   d. The degree of success resulting from the procedure
   e. Conclusions drawn from the comparison of results

Unit IV—Foundations of Genetic Engineering
Student Handout

1. You will form a team with two other students to conduct the procedure to extract DNA material from a plant or animal source.

2. Your teacher will provide, or assign responsibility for providing, the following to your team:
   - ❑ Organic material (plant or animal sources) to be used as subjects of the DNA extraction procedure
   - ❑ Equipment and material to conduct the procedure
   - ❑ A description or plan for extracting DNA, including maximum time for the procedure

3. Your team will conduct the procedure a minimum of twice; if time permits, each member of your team will conduct the procedure to duplicate and verify results.

4. After completing the procedure, your team will rotate through all other team stations and visually compare one of your samples to the one or two samples remaining at each team's station.

5. After completing the rotation through all stations, your team will briefly summarize in a written report the results of your procedure and your findings during the visual comparison of other teams' results. The report should be no more than two short paragraphs.

6. Assessment will be based on the quality of your effort for the following factors:
   a. Application of proper procedure and technique during the laboratory exercise
   b. Team cohesiveness (i.e., how well team members worked together)
   c. The time needed to conduct the procedure
   d. The degree of success resulting from the procedure
   e. Conclusions drawn from the comparison of results

Biotechnology: Applications in Agriculture

Unit IV—Foundations of Genetic Engineering
Scoring Guide
Laboratory Subject/Team Members_____

Criteria	0 Points	1 Point	2 Points	3 Points	4 Points	Weight	Total
Proper procedure and laboratory technique were used	Failed	Poor	Fair	Good	Excellent	X 12.5	
Team members worked well together	Failed	Poor	Fair	Good	Excellent	X 7.5	
Amount of time for procedure was appropiate	Failed	Poor	Fair	Good	Excellent	X 2.5	
Procedure results were successful	Failed	Poor	Fair	Good	Excellent	X 1.25	
Conclusions from comparisons were thorough and valid	Failed	Poor	Fair	Good	Excellent	X 1.25	
TOTAL							

Final Assessment Total _____/100 pts.

Comments:

Biotechnology:
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Curriculum Guide: *Biotechnology: Applications in Agriculture*

Unit: V. Animal Technologies

Unit Objective:

Students will demonstrate an understanding of a biotechnology technique applied to livestock production by describing the process and benefits of bovine embryo transfer in a pamphlet, poster, or another format, as determined by the instructor.

Show-Me Standards: 3.4, SC8

References:

Biotechnology: Applications in Agriculture. University of Missouri-Columbia, Instructional Materials Laboratory, 1998.

Bovine Embryo Transfer: 1990 Short Course Proceedings. Fort Collins, CO: Colorado State University, Animal Reproduction Laboratory, 1990.

Bovine Embryo Transfer. The University of Findlay. Accessed November 6, 2003, from http://www.findlay.edu/users/brennan/eqst131/fa99/mowrer/index.htm?o=0.

Grimes, J. F. *Utilization of Embryo Transfer in Beef Cattle*. Ohio State University Extension. Accessed December 3, 2003, from http://ohioline.osu.edu/anr-fact/0017.html.

Seidel, G. E., Jr., Seidel, S. M., & Bowen, R. A. *Bovine Embryo Transfer Procedures*. Fort Collins, CO: Colorado State University, Animal Reproduction Laboratory, 1980.

Trans Ova Genetics. Accessed March 19, 2004, from http://www.transova.com/.

Students may use additional outside sources to complete this activity.

Instructional Strategies/Activities:

- Students will engage in study questions in lessons 1 through 4.
- Students will complete AS 2.1, Examining Embryos.
- Additional activities that relate to the unit objective can be found under the heading "Other Activities" in the following locations: p. V-4 (2 or 3), p. V-15 (2 or 3), and p. V-41.

Performance-Based Assessment:

Students will work in groups of three to develop a pamphlet or poster designed to describe the process and the benefits of bovine embryo transfer. Optionally, students could present their findings in a slide show using presentation software.

Assessment will be based on the accuracy, organization, and clarity of the information cited in the pamphlet or poster. Additional consideration will be given to the quality of the material produced. Assessment also will take into account grammar, spelling, punctuation, and capitalization.

Unit V—Animal Technologies
Instructor Guide

The instructor should assign the performance-based assessment activity at the beginning of the unit. Students will work toward completing the activity as they progress through the unit lessons. The assessment activity will be due at the completion of the unit.

1. Students will work in teams of three to focus their efforts on the production of a pamphlet or poster describing the process and benefits of bovine embryo transfer. (NOTE: If preferred, have students present their findings in a slide show using presentation software. Tell students what format is preferable. Adjust the student handout and scoring guide accordingly as needed.)

2. Team members will work as a unit to research the topic of bovine embryo transfer.

3. Students may use material in the unit and additional outside material to complete their posters or pamphlets. Students may not use the source material word for word and must provide a complete bibliography of their sources along with their presentation.

4. After completing research, the team will develop, outline, and write material for a pamphlet or poster describing the process and benefits of bovine embryo transfer.

5. Assessment will evaluate the team's effort and will be based on the accuracy, organization, clarity, and quality of the information in the poster or pamphlet. Spelling, grammar, punctuation, and capitalization also will be factors in the assessment.

Unit V—Animal Technologies
Student Handout

1. You will work in a team with two other students to focus your efforts on the production of a presentation describing the process and benefits of bovine embryo transfer. The presentation may be a pamphlet, poster, or another format, as directed by your instructor.

2. You and your team members will work together to research the topic of bovine embryo transfer.

3. You may use material in the unit and additional outside material to complete your presentation. You may not use the source material word for word and must provide a complete bibliography of your sources along with your presentation.

4. After completing research, your team will develop, outline, and write material for a pamphlet, poster, or other format describing the process and benefits of bovine embryo transfer.

5. Assessment will evaluate your team's effort and will be based on the accuracy, organization, clarity, and quality of the information in the presentation. Spelling, grammar, punctuation, and capitalization also will be factors in the assessment.

Biotechnology: Applications in Agriculture

Unit V—Animal Technologies
Scoring Guide
Team Members_____

Assessment Area	Criteria	0 Points	1 Point	2 Points	3 Points	4 Points	Weight	Total
Poster or Pamphlet Content and Quality	Accuracy of information	Failed	Poor	Fair	Good	Excellent	X 5.625	
	Organization of information	Failed	Poor	Fair	Good	Excellent	X 5.625	
	Clarity of Information	Failed	Poor	Fair	Good	Excellent	X 5.625	
	Quality of Overall Effort	Failed	Poor	Fair	Good	Excellent	X 5.625	
Technical Considerations	❑ Spelling ❑ Grammar ❑ Punctuation ❑ Capitalization	0 criteria met	1 criterion met	2 criteria met	3 criteria met	All 4 criteria met	X 2.5	
TOTAL								

Final Assessment Total _____/100 pts.

Comments:

Biotechnology:
Applications in Agriculture

Curriculum Guide: *Biotechnology: Applications in Agriculture*

Unit: VI. Plant Technologies

Unit Objective:

Students will demonstrate an understanding of the purpose and process of electrophoresis by constructing and using an electrophoresis device and writing a summary of the results.

Show-Me Standards: 1.2, SC3

References:

Biotechnology: Applications in Agriculture. University of Missouri-Columbia, Instructional Materials Laboratory, 1998.

Electrophoresis. Nexus Research Group. Accessed August 11, 2003, from http://www.nexusresearchgroup.com/fun_science/electrophoresis.htm.

Gel Electrophoresis – Teacher Instructions. Biological Sciences Initiative. University of Colorado. Accessed December 3, 2003, from http://www.colorado.edu/Outreach/BSI/pdfs/electrophoresis_teacher.pdf.

Instruction Guide. Genetic Science Learning Center. University of Utah. Accessed December 3, 2003, from http://gslc.genetics.utah.edu/units/activities/electrophoresis/guide.cfm.

Lane, L., Loh, P., & Roe, B. A. "Experiment #5 – Butter Dish Electrophoresis."*Biotechnology & Recombinant DNA Techniques for Middle and High School Students and Teachers*. Accessed August 11, 2003, from http://www.genome.ou.edu/HHMI/workshop.pdf.

Moeed, A. *Electrophoresis Procedure*. AgResearch 2000. Accessed November 4, 2003, from http://www.agresearch.cri.nz/scied/search/tools/electro/background_electro_photos.htm.

Teacher Guide: Build a Gel Electrophoresis Chamber. Genetic Science Learning Center. University of Utah. Accessed December 3, 2003, from http://gslc.genetics.utah.edu/teachers/units/basics/gelbox_build.pdf.

Instructional Strategies/Activities:

- Students will engage in study questions in lessons 1 through 5.
- Students will complete AS 3.1, The Current State of Plant Biotechnology; and AS 4.1, Designer Plants—The Agricultural Products of the Future.
- Additional activities that relate to the unit objective can be found under the heading "Other Activities" in the following locations: p. VI-4 and p. VI-15 (1).

Performance-Based Assessment:

Students will work in teams of three to build an electrophoresis device. The instructor will provide materials and directions. In addition to constructing the device, each team will use its device to separate DNA material into groups based on length.

Assessment will be based on the application of the proper construction procedure and the time required, the application of the proper DNA processing procedure and the time required, and the degree of success resulting from the procedure. Laboratory technique and team cohesiveness also will be factors in the assessment.

Unit VI—Plant Technologies
Instructor Guide

The instructor should assign the performance-based assessment activity at the beginning of the unit. Students will work toward completing the activity as they progress through the unit lessons. The assessment activity will be due at the completion of the unit.

1. Students will form teams of three to assemble a simple electrophoresis device and to use it to separate DNA material.

2. The teacher will provide to each team of students the following:
   - ❑ Equipment and material to assemble a simple electrophoresis device
   - ❑ A description or plan for assembling the device using the equipment and material provided (NOTE: The teacher is advised to consult one or more of the web sites listed among the references for this performance-based assessment activity to determine the specific equipment, material, and assembly procedure outline to supply to each team of students.)
   - ❑ Directions for processing DNA samples with the electrophoresis device each team has assembled (NOTE: The teacher is advised to consult one or more of the web sites listed among the references for this performance-based assessment activity to determine the DNA material to be processed and for a list of the material needed and description of the process to be conducted with the electrophoresis device.)

3. Each team will construct an electrophoresis device using the equipment and materials provided and according to the procedure outlined by the teacher.

4. After completing assembly of the electrophoresis device, each team will process the designated DNA material using the device the team assembled. If time permits, each member of the team will conduct his or her own processing of the DNA material to serve as duplication and verification of the process.

5. After completing the processing of DNA material, each team will briefly summarize in a written report the results of its procedure or multiple procedures. The report should not be more than two short paragraphs.

6. Assessment will be based on the quality of effort for the following factors:
   a. Application of the proper procedure to construct the electrophoresis device
   b. Time required to build the device
   c. Application of the proper procedure during the DNA material processing exercise
   d. The time needed to conduct the processing
   e. The degree of success resulting from the DNA material processing

   Additional factors to be considered are laboratory technique (i.e., orderly, clean, and careful use of facilities and equipment) and cohesiveness of the team (i.e., how well team members worked with each other).

Unit VI—Plant Technologies
Student Handout

1. You will form a team with two other students to assemble a simple electrophoresis device and to use it to separate DNA material.

2. The teacher will provide to your team the following:
   - ❑ Equipment and material to assemble a simple electrophoresis device
   - ❑ A description or plan for assembling the device using the equipment and material provided
   - ❑ Directions for processing DNA samples with the electrophoresis device each team has assembled

3. Your team will construct an electrophoresis device using the equipment, materials, and directions provided.

4. After completing assembly of the electrophoresis device, your team will process the designated DNA material using the device your team assembled. If time permits, each member of your team will conduct his or her own processing of the DNA material to serve as a duplication and verification of the process.

5. After completing the processing of DNA material, your team will briefly summarize in a written report the results of its procedure or multiple procedures. The report should not be more than two short paragraphs.

6. Assessment will be based on the quality of your team's effort for the following factors:
   a. Application of the proper procedure to construct the electrophoresis device
   b. Time required to build the device
   c. Application of the proper procedure during the DNA material processing exercise
   d. The time needed to conduct the processing
   e. The degree of success resulting from the DNA material processing

   Additional factors to be considered are laboratory technique (i.e., orderly, clean, and careful use of facilities and equipment) and cohesiveness of the team (i.e., how well team members worked with each other).

Biotechnology: Applications in Agriculture

Unit VI—Plant Technologies
Scoring Guide
Experiment Topic/Team Members _____

Criteria	0 Points	1 Point	2 Points	3 Points	4 Points	Weight	Total
Proper construction procedure was used	Failed	Poor	Fair	Good	Excellent	X 3.75	
Amount of time to build the device was appropriate (the less time, the better)	Failed	Poor	Fair	Good	Excellent	X 2.5	
Proper DNA processing procedure was used	Failed	Poor	Fair	Good	Excellent	X 3.75	
Amount of time to conduct the procedure was appropriate (the less time, the better)	Failed	Poor	Fair	Good	Excellent	X 2.5	
Procedure results were successful	Failed	Poor	Fair	Good	Excellent	X 10	
Proper laboratory technique was used	Failed	Poor	Fair	Good	Excellent	X 1.25	
Team worked well together	Failed	Poor	Fair	Good	Excellent	X 1.25	
TOTAL							

Final Assessment Total _____/100 pts.

Comments: