

Biotechnology Foundations in Technology Education

8468 36 weeks

Table of Contents

Acknowledgments.....	1
Course Description.....	2
Task Essentials Table.....	3
Curriculum Framework.....	6
Exploring Foundations in Biotechnology	6
Preparing for Biotechnology Experiences	13
Exploring Biochemistry	17
Investigating Genetic Engineering.....	24
Applying Biotechnology to the Environment	31
Examining the Role of Biotechnology in Agriculture	36
Exploring Bioprocessing.....	40
Examining the Role of Biotechnology in Medicine.....	46
Investigating Forensics	51
Understanding Biomedical Engineering	55
Examining Social Aspects and Ethics of Biotechnology	58
SOL Correlation by Task.....	61
Entrepreneurship Infusion Units	67
Appendix: Credentials, Course Sequences, and Career Cluster Information	69

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Course Description

Suggested Grade Level: 10 or 11 or 12

This course focuses on various techniques that are used to modify living organisms, or parts of organisms, to improve plants and animals, and the development of microorganisms for specific purposes. Student activities range from bioprocessing and deoxyribonucleic acid (DNA) analysis, to medicine, and the environment. Students gain insight and understanding about biotechnology career fields.

Task Essentials Table

- Tasks/competencies designated by plus icons (+) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (○) are optional
- Tasks/competencies designated by minus icons (−) are omitted
- Tasks marked with an asterisk (*) are sensitive.

Task Number	8468	Tasks/Competencies
Exploring Foundations in Biotechnology		
39	+	Define <i>biotechnology</i> .
40	+	Give examples of biotechnology milestones.
41	+	Describe social implications of biotechnology.
42	+	Describe technology transfer in biotechnology.
43	+	Identify careers related to biotechnology.
Preparing for Biotechnology Experiences		
44	+	Demonstrate understanding of required safety practices and procedures in the classroom and laboratory environment.
45	+	Use the scientific method and the technological/engineering method to solve biotechnology problems.
46	+	Analyze data generated from lab activities.
Exploring Biochemistry		
47	+	Explain the roles of sciences applicable to biotechnology, including organic chemistry, biochemistry, and microbiology.
48	+	Prepare buffer stock solutions and reagents.
49	+	Explain the structure and cellular function of organic macromolecules.
50	+	Analyze how organic macromolecules are manipulated and detected, using biotechnological tools.
51	+	Explain the function of carbohydrates and lipids.

52	+	Differentiate among the types of proteins found in organisms.	
53	+	Explain the basic principles of protein utilization in organisms.	
54	+	Explain the advantages of protein utilization in organisms.	
55	+	Illustrate the function or use of an enzyme, using a prototype or model.	
Investigating Genetic Engineering			
56	+	Define <i>genetic engineering</i> .	
57	+	Develop a timeline of genetic engineering milestones.	
58	+	Model deoxyribonucleic acid (DNA).	
59	+	Assess the importance of the genetic information contained in DNA.	
60	+	Describe the function of DNA, ribonucleic acid (RNA), and protein in living cells.	
61	+	Demonstrate how the structure of DNA influences its function, analysis, and manipulation.	
62	+	Demonstrate how manipulation of nucleic acids through genetic engineering alters the function of proteins and subsequent cellular processes.	
63	+	Explain how genetic engineering is used in plants, animals, and medicine.	
64	+	Explain the importance of genetic mapping.	
65	+	Analyze social implications of genetic engineering.	
Applying Biotechnology to the Environment			
66	+	Assess the social implication of environmental quality management.	
67	+	Investigate biotreatment systems.	
68	+	Examine the potential benefits of biological controls in plant and animal systems.	
69	+	Design a bioremediation system.	
70	+	Plan a biorestitution system.	

71	+	Demonstrate the use of biotechnology to restore or remediate contaminated environments.
Examining the Role of Biotechnology in Agriculture		
72	+	Demonstrate various procedures used with tissue cultures.
73	+	Analyze social implications of biotechnology in agriculture.
74	+	Identify microbial applications in agriculture.
75	+	Summarize the role of biotechnology in crop modification.
76	+	Identify factors that jeopardize food safety.
77	+	Examine advances of biotechnology in food science.
Exploring Bioprocessing		
78	+	Define <i>bioprocessing</i> .
79	+	Describe the process of fermentation.
80	+	Prepare a product generated from bioprocessing.
81	+	Describe genetic engineering applications used in bioprocessing.
82	+	Demonstrate the application of microbes in bioprocessing.
83	+	Describe the social and environmental effects of bioprocessing.
84	+	Perform separation and purification techniques.
85	+	Illustrate the design of bioprocessing systems.
Examining the Role of Biotechnology in Medicine		
86	+	Identify the influence of biotechnology on medicine.
87	+	Describe the ethical, legal, and social implications of biomedicine.
88	+	Explain vaccine (i.e., immunology) research and development.
89	+	Describe the effects of molecular research on society.
90	+	Identify emerging healthcare technologies.
91	+	Explain the applications of genetics in pharmacology.

92	+	Describe the effects of biotechnology on preventive healthcare.
Investigating Forensics		
93	+	Define <i>forensic science</i> .
94	+	Describe situations in which medical forensics can be used.
95	+	Describe situations in which forensic science can be used in criminal investigations.
96	+	Describe situations in which biological forensic science can be used.
97	+	Demonstrate the basic instrumentation used in DNA analysis for forensic purposes.
Understanding Biomedical Engineering		
98	+	Define <i>bioengineering</i> .
99	+	Identify uses of nanobiotechnology.
100	+	Identify examples of biowarfare.
101	+	Design and produce a biomechanism.
Examining Social Aspects and Ethics of Biotechnology		
102	+	Define <i>bioethics</i> .
103	+	Assess implications of biotechnology, including gene therapy, patenting of living tissue, and cloning.
104	+	Differentiate among ethical principles that reflect social, religious, economic, and political perspectives.
105	+	Identify regulations that affect biotechnology.

Legend: + Essential ○ Non-essential - Omitted

Curriculum Framework

Exploring Foundations in Biotechnology

Task Number 39

Define *biotechnology*.

Definition

Definition should follow the language provided by the Office of Technology Assessment of the U.S. Congress (OTA): “Any technique that uses living organisms (or parts of an organism) to make or modify products, to improve plants or animals, or to develop microorganisms for specific use.”

Process/Skill Questions

- What is the origin of the word *biotechnology*?
- What resources describe biotechnology?
- What is the main component used for biotechnology?
- What are DNA and genes?

ITEEA National Standards

1. The Characteristics and Scope of Technology

15. Agricultural and Related Biotechnologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Biotechnology Design

Technology Bowl (Written and Oral)

Task Number 40

Give examples of biotechnology milestones.

Definition

Examples should include milestones from early cultures (e.g., China, Greece, Egypt) as well as more recent milestones. They should include examples from various categories, such as inventions, discoveries, artifacts, and processes.

Process/Skill Questions

- How have historical events influenced and been influenced by biotechnology?
- What discoveries have contributed to recent breakthroughs in biotechnology?
- What are some of the advances that resulted from the human genome project? How did this influence gene editing?
- How did these discoveries lead to the development of recombinant DNA technology? How are these advances used today?
- What are the future applications of biotechnology? How can the field be used for future breakthroughs in medicine and science?
- What are the implications of genomics and proteomics on biotechnology and current healthcare?

ITEEA National Standards

7. The Influence of Technology on History

TSA Competitive Events

Biotechnology Design

Task Number 41

Describe social implications of biotechnology.

Definition

Description should include positive and negative, desired and undesired effects. It should include cultural, economic, financial, political, ethical, legal, and other implications.

Process/Skill Questions

- What are the differences among moral, ethical, and legal biotechnology issues?
- How is biotechnology interrelated with ethical, legal, and social issues (ELSI)?
- When making biotechnology decisions, why is it important to include cultural issues in the decision-making process?
- How do attitudes about the use of biotechnology compare regionally, nationally, and internationally?

- What are historical examples of the social implications of biotechnology decisions or events?
- What is the role of biotechnology in different countries?
- How are biotechnology research and development funded?
- What are the effects of marketing and media on the public perception of biotechnology research?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Biotechnology Design

Engineering Design

Essays on Technology

Task Number 42

Describe technology transfer in biotechnology.

Definition

Description should include examples of technology transfer from outside biotechnology into biotechnology and vice versa, as well as within or among biotechnology fields.

Process/Skill Questions

- What have been important effects of technology transfer related to biotechnology?
- Why is interdisciplinary collaboration important in technology transfer?
- What is an example of spin-off technology?
- How has the coupling of technologies created new fields in biotechnology (e.g., mathematical biology, bioinformatics)?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Biotechnology Design

Engineering Design

Task Number 43

Identify careers related to biotechnology.

Definition

Identification should include careers in agriculture, medicine, and engineering. The focus should be on careers within each of the following main areas:

- Research and development
- Agriculture
- Environmental applications
- Biomanufacturing
- Teaching
- Human health and diagnostics

For each career, the following should be addressed:

- Responsibilities
- Salaries
- Working environment
- Required education/training
- Job outlook

Process/Skill Questions

- What certifications, licenses, and degrees are available for careers in biotechnology?
- What is the outlook for careers in biotechnology?
- What resources have information about careers in biotechnology?
- What educational opportunities in biotechnology are available in higher education?
- What is the role of the Technology Student Association?

Related Standards of Learning

English

10.5

The student will read, interpret, analyze, and evaluate nonfiction texts.

- a. Analyze text features and organizational patterns to evaluate the meaning of texts.
- b. Recognize an author's intended audience and purpose for writing.
- c. Skim materials to develop an overview and locate information.
- d. Compare and contrast informational texts for intent and content.
- e. Interpret and use data and information in maps, charts, graphs, timelines, tables, and diagrams.
- f. Draw conclusions and make inferences on explicit and implied information using textual support as evidence.
- g. Analyze and synthesize information in order to solve problems, answer questions, and generate new knowledge.
- h. Analyze ideas within and between selections providing textual evidence.
- i. Summarize, paraphrase, and synthesize ideas, while maintaining meaning and a logical sequence of events, within and between texts.
- j. Use reading strategies throughout the reading process to monitor comprehension.

10.8

The student will find, evaluate, and select credible resources to create a research product.

- a. Verify the accuracy, validity, and usefulness of information.
- b. Analyze information gathered from diverse sources by identifying misconceptions, main and supporting ideas, conflicting information, and point of view or bias.
- c. Evaluate and select evidence from a variety of sources to introduce counter claims and to support claims.
- d. Cite sources for both quoted and paraphrased ideas using a standard method of documentation, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA).
- e. Define the meaning and consequences of plagiarism and follow ethical and legal guidelines for gathering and using information.
- f. Demonstrate ethical use of the Internet.

11.5

The student will read, interpret, analyze, and evaluate a variety of nonfiction texts including employment documents and technical writing.

- a. Apply information from texts to clarify understanding of concepts.
- b. Read and correctly interpret an application for employment, workplace documents, or an application for college admission.
- c. Analyze technical writing for clarity.
- d. Paraphrase and synthesize ideas within and between texts.
- e. Draw conclusions and make inferences on explicit and implied information using textual support.

- f. Analyze multiple texts addressing the same topic to determine how authors reach similar or different conclusions.
- g. Analyze false premises, claims, counterclaims, and other evidence in persuasive writing.
- h. Recognize and analyze use of ambiguity, contradiction, paradox, irony, sarcasm, overstatement, and understatement in text.
- i. Generate and respond logically to literal, inferential, evaluative, synthesizing, and critical thinking questions about the text(s).

11.8

The student will analyze, evaluate, synthesize, and organize information from a variety of credible resources to produce a research product.

- a. Critically evaluate quality, accuracy, and validity of information.
- b. Make sense of information gathered from diverse sources by identifying misconceptions, main and supporting ideas, conflicting information, point of view or bias.
- c. Synthesize relevant information from primary and secondary sources and present it in a logical sequence.
- d. Cite sources for both quoted and paraphrased ideas using a standard method of documentation, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA).
- e. Define the meaning and consequences of plagiarism and follow ethical and legal guidelines for gathering and using information.
- f. Demonstrate ethical use of the Internet.

12.5

The student will read, interpret, analyze, and evaluate a variety of nonfiction texts.

- a. Use critical thinking to generate and respond logically to literal, inferential, and evaluative questions about the text(s).
- b. Identify and synthesize resources to make decisions, complete tasks, and solve specific problems.
- c. Analyze multiple texts addressing the same topic to determine how authors reach similar or different conclusions.
- d. Recognize and analyze use of ambiguity, contradiction, paradox, irony, overstatement, and understatement in text.
- e. Analyze false premises claims, counterclaims, and other evidence in persuasive writing.

12.8

The student will analyze, evaluate, synthesize, and organize information from a variety of credible resources to produce a research product.

- a. Frame, analyze, and synthesize information to solve problems, answer questions, and generate new knowledge.

- b. Analyze information gathered from diverse sources by identifying misconceptions, main and supporting ideas, conflicting information, point of view, or bias.
- c. Critically evaluate the accuracy, quality, and validity of the information.
- d. Cite sources for both quoted and paraphrased ideas using a standard method of documentation, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA).
- e. Define the meaning and consequences of plagiarism and follow ethical and legal guidelines for gathering and using information.
- f. Demonstrate ethical use of the Internet.

ITEEA National Standards

1. The Characteristics and Scope of Technology

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

4. The Cultural, Social, Economic, and Political Effects of Technology

7. The Influence of Technology on History

TSA Competitive Events

Biotechnology Design

Digital Video Production

Engineering Design

Preparing for Biotechnology Experiences

Task Number 44

Demonstrate understanding of required safety practices and procedures in the classroom and laboratory environment.

Definition

Demonstration should

- reflect knowledge of general safety rules (e.g., those related to fire, electricity, infection prevention, transmission of diseases), aseptic technique, chemical safety, and industry-specified guidelines (e.g., Occupational Safety and Health Administration [OSHA] and Clinical Laboratory Improvement Amendment [CLIA]), Environmental Protection Agency (EPA), and right to know
- demonstrate health and safety practices to include safety data sheets (SDS) emergency equipment, storage of chemicals, and maintenance of equipment
- follow manufacturers' guidelines for equipment and material use
- include health and safety procedures related to the use and disposal of sharps, hazardous materials, personal protective equipment (PPE), and other items.

Process/Skill Questions

- What are specific rules and procedures involved in aseptic technique?
- Why are aseptic rules important?
- What is the chain of infection? Why is it important?
- What are appropriate cleanup procedures for hazardous materials (HAZMAT)?
- What are SDS? Why are they important?
- Why is documentation important to safety?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

14. Medical Technologies

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Biotechnology Design

Task Number 45

Use the scientific method and the technological/engineering method to solve biotechnology problems.

Definition

Use involves

- identifying a problem
- researching
- forming a hypothesis
- planning an experiment
- performing an experiment
- analyzing data
- forming a conclusion
- communicating results.

Use of the technological/engineering method should be based on the understanding that this method is concerned with the phenomenon of the human-designed world and with obtaining artifacts and solutions to problems. The steps include

- identifying the need or opportunity for an engineering solution
- defining a design problem
- identifying the constraints of a design problem
- researching potential solutions to a design problem
- generating multiple solutions (brainstorming) to a design problem
- sketching solutions for a design problem
- evaluating potential solutions to a design problem
- choosing the optimal solution to a design problem
- implementing the solutions to the design problem
- communicating the solution to stakeholders
- testing the solution
- evaluating the test results
- improving the initial solution
- communicating the solution to stakeholders.

Process/Skill Questions

- What are the steps in the scientific method? Why is each step important?
- What are the steps in the technological/engineering method? Why is each step important?
- What are the similarities and differences between the scientific method and the technological/engineering method?
- What conditions require using the scientific method? What conditions require using the technological/engineering method?

ITEEA National Standards

11. Apply the Design Processes

8. The Attributes of Design

TSA Competitive Events

Engineering Design

Scientific and Technical Visualization (SciVis)

Task Number 46

Analyze data generated from lab activities.

Definition

Analysis should include

- collection of data from experiments
- comparative research
- observations
- documentation (i.e., lab journals and logs)
- application of formulas, conclusions, and quality control (e.g., identification of quality standard, data validation).

Process/Skill Questions

- What are quality controls, and what is the purpose of having them?
- How are quality controls maintained?
- What would be the consequences of not maintaining quality controls?
- What types of questions need to be answered when collecting data for an experiment?
- How and why are data collected from lab activities?
- How may the data be documented?
- What different methods are used to document data?
- How are data used to model biotechnical processes?
- How can the data analysis prove or disprove the question of the experiment?
- How do the results from the quality controls affect the data interpretation?

TSA Competitive Events

Biotechnology Design

Engineering Design

Exploring Biochemistry

Task Number 47

Explain the roles of sciences applicable to biotechnology, including organic chemistry, biochemistry, and microbiology.

Definition

Explanation should include the comparison of each field's similarities and differences.

Process/Skill Questions

- What is the difference between basic organic chemistry and biochemistry?
- How are microbes used in biotechnology?
- What types of microbes are used in biotechnology?
- What is the importance of the type of microbe used in biotechnology?
- What criteria determine the type of microbe to be used in biotechnology?
- How are biochemical reactions used in biotechnology research?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Biotechnology Design

Technology Bowl (Written and Oral)

Task Number 48

Prepare buffer stock solutions and reagents.

Definition

Preparation should include calculation of ingredients.

Process/Skill Questions

- What is the purpose of buffer stock solutions?
- What are reagents?
- What calculations are needed to prepare ingredients?

ITEEA National Standards

14. Medical Technologies

Task Number 49

Explain the structure and cellular function of organic macromolecules.

Definition

Explanation should include the following four types of macromolecules:

- Lipids
- Carbohydrates
- Proteins
- Nucleic acids.

Process/Skill Questions

- What are macromolecules?
- What are the types of macromolecules? What are their purposes?
- How are macromolecules used in the cell?
- How can biotechnology techniques create macromolecules and affect cellular activities?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Biotechnology Design

Essays on Technology

Extemporaneous Presentation

Task Number 50

Analyze how organic macromolecules are manipulated and detected, using biotechnological tools.

Definition

Analysis should describe how current research and manipulation of carbohydrates, lipids, proteins and nucleic acids have been designed within the field of biochemistry for innovative processes.

Process/Skill Questions

- How are organic macromolecules manipulated?
- What are some innovative uses for each group of these new macromolecules?
- What mechanisms (sensors and gauges) are used to monitor carbohydrates?
- How are cancer diagnostics and therapeutics possible?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Biotechnology Design

Essays on Technology

Extemporaneous Presentation

Task Number 51

Explain the function of carbohydrates and lipids.

Definition

Explanation should include the monomers and polymers of both carbohydrates and lipids and examples of both.

Process/Skill Questions

- What are the functions of carbohydrates in an organism?
- What are the functions of lipids?
- What are the types of carbohydrates?
- What are the types of lipids?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Technology Bowl (Written and Oral)

Task Number 52

Differentiate among the types of proteins found in organisms.

Definition

Differentiation should include the various types of proteins, including

- hormones
- receptors
- contractile
- structural
- storage
- transport
- defensive
- enzymatic.

Process/Skill Questions

- What are examples of the types of proteins?
- What are the functions of the types of proteins?
- How are proteins used in organisms?
- How are proteins expressed?
- What are the structures of protein, and how do they affect the functionality of the protein?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Biotechnology Design

Essays on Technology

Extemporaneous Presentation

Task Number 53

Explain the basic principles of protein utilization in organisms.

Definition

Explanation should

- state that a protein is a substance consisting of amino acids, which are important in the nutrition and growth of an organism
- include the fact that the use of proteins is essential in the maturation rate of organisms
- include the fact that the process of making a protein involves DNA (gene) to RNA to protein.

Process/Skill Questions

- How are proteins used in genome projects?
- Why is protein structure important to function?
- How can protein structure be manipulated?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

13. Assess the Impact of Products and Systems

TSA Competitive Events

Biotechnology Design

Task Number 54

Explain the advantages of protein utilization in organisms.

Definition

Explanation should emphasize that the growth rate of an organism can be increased dramatically through the protein utilization process and that, with each new discovery, this rapidly growing field of research produces new techniques to enhance systems.

Process/Skill Questions

- What are the advantages of protein utilization?
- What effect does the protein utilization process have on the environment of an organism?
- What are current trends in research of the protein utilization process?
- How does public opinion influence research?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Technology Bowl (Written and Oral)

Task Number 55

Illustrate the function or use of an enzyme, using a prototype or model.

Definition

Illustration should use a model or prototype with all the basic components for a working system and should also incorporate an explanation of how the model works, including what type of enzyme is used, how the enzyme is acquired, what molecular process takes place during data storage, and what the advantages are for using this type of biotechnology.

Process/Skill Questions

- What is an organism that can be used for a model?
- What are the characteristics of the model? What are the parts, and how do they work?
- What mechanisms are used to monitor the system? How is the output of the enzyme system measured?
- What is the real-life application of the enzyme?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Biotechnology Design

Investigating Genetic Engineering

Task Number 56

Define *genetic engineering*.

Definition

Definition should include the direct manipulation of an organism's genome by introducing or eliminating specific genes using biotechnology techniques.

Process/Skill Questions

- What is recombinant DNA?
- How is the exact code of the desired gene determined when starting a gene manipulation experiment?
- How are genes introduced or eliminated from the genome of an organism using biotechnology techniques?
- What are restriction enzymes?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Biotechnology Design

Technology Bowl (Written and Oral)

Task Number 57

Develop a timeline of genetic engineering milestones.

Definition

Development should include major events in genetic engineering such as

- Mendel's discovery
- DNA modeling
- gene therapy
- cloning
- DNA sequencing.

Process/Skill Questions

- What was Mendel's contribution to the field of genetic engineering?
- What is the importance of DNA modeling?
- What is the importance of gene therapy in modern medicine?
- What is cloning, and why is it controversial?
- How have DNA sequencing techniques evolved?

ITEEA National Standards

6. The Role of Society in the Development and Use of Technology

7. The Influence of Technology on History

TSA Competitive Events

Biotechnology Design

Essays on Technology

Task Number 58

Model deoxyribonucleic acid (DNA).

Definition

Modeling should include a physical representation of genes and an explanation of each.

Process/Skill Questions

- How can the DNA structure be represented in a model?
- What shape will the model produce?
- Where are specific genes located?

ITEEA National Standards

14. Medical Technologies

TSA Competitive Events

Biotechnology Design

Task Number 59

Assess the importance of the genetic information contained in DNA.

Definition

Assessment should include having the student construct the components of a DNA model and explain DNA's importance to genetic information.

Process/Skill Questions

- How is the DNA molecule different in prokaryotes and eukaryotes?
- What are the components of a DNA molecule?
- How does DNA affect the genetic makeup of a living organism?
- What options does one have if one does not have DNA? What techniques can be used to get the desired gene?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Essays on Technology

Task Number 60

Describe the function of DNA, ribonucleic acid (RNA), and protein in living cells.

Definition

Description should include

- definition of *deoxyribonucleic acid* (DNA)
- definition of *ribonucleic acid* (RNA)
- the relationship among protein, DNA, and RNA in living cells.

Process/Skill Questions

- What are the monomers of nucleic acids?
- What is gene expression?
- What techniques are used to assure one has the correct DNA gene prior to beginning genetic engineering experiments?

ITEEA National Standards

14. Medical Technologies

TSA Competitive Events

Biotechnology Design

Task Number 61

Demonstrate how the structure of DNA influences its function, analysis, and manipulation.

Definition

Demonstration should include a representation of how the structure of DNA influences its function, analysis, and manipulation.

Process/Skill Questions

- What is the function of DNA?
- How can DNA be analyzed?
- What is the purpose of manipulating DNA?

ITEEA National Standards

14. Medical Technologies

TSA Competitive Events

Biotechnology Design

Task Number 62

Demonstrate how manipulation of nucleic acids through genetic engineering alters the function of proteins and subsequent cellular processes.

Definition

Demonstration may include the following techniques of DNA extraction, manipulation, and analysis:

- Centrifugation
- Precipitation
- Spooling
- Electrophoresis
- Restriction enzymes
- Karyotypes
- Polymerase chain reaction (PCR)

Process/Skill Questions

- What laboratory equipment is used for the extraction of DNA?

- What lab safety precautions should be taken when performing DNA extraction?
- What part do centrifugation, precipitation, and spooling play in extraction of DNA?
- What is PCR?

ITEEA National Standards

11. Apply the Design Processes

12. Use and Maintain Technological Products and Systems

14. Medical Technologies

Task Number 63

Explain how genetic engineering is used in plants, animals, and medicine.

Definition

Explanation should include current information on the contribution of genetic engineering in developing disease prevention through diagnostics and therapeutics.

Process/Skill Questions

- How is genetic engineering used to diagnose disease?
- How is genetic engineering used to treat disease?
- How is genetic engineering used to personalize therapeutics?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

Biotechnology Design

Essays on Technology

Extemporaneous Presentation

Task Number 64

Explain the importance of genetic mapping.

Definition

Explanation should include descriptions of genome mapping projects and their contributions to genetic engineering.

Process/Skill Questions

- What is genetic mapping?
- What are the steps of a genetic mapping project?
- What value does this information have to biotechnology research?
- What products are on the market as a result of the genome projects?
- What are examples of genome projects?
- What is the value of informational components of genetic mapping projects?

ITEEA National Standards

14. Medical Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Digital Video Production

Technology Bowl (Written and Oral)

Task Number 65

Analyze social implications of genetic engineering.

Definition

Analysis should include ethical, humanitarian, economic, and legal implications.

Process/Skill Questions

- Who benefits from genetic engineering?
- How do government regulations affect product development and distribution?
- How does consumer confidence affect product development and distribution?
- How do public perceptions affect product development and distribution?

ITEEA National Standards

14. Medical Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Engineering Design

Essays on Technology

Applying Biotechnology to the Environment

Task Number 66

Assess the social implication of environmental quality management.

Definition

Assessment should include the history, legislation, and organizations associated with environmental quality management, as well as the effects of environmental quality management on society.

Process/Skill Questions

- What are some current environmental issues associated with biotechnology?
- What is the definition of GMO?
- How has media/social media affected the public perception of GMO?
- How might current environmental issues associated with biotechnology be categorized?
- Which environmental issues in biotechnology are most likely to be used for quality management?
- What would be the consequences of not having environmental quality management?
- How has society benefited from environmental quality management?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Digital Video Production

Engineering Design

Task Number 67

Investigate biotreatment systems.

Definition

Investigation should include

- the purpose of biotreatment systems
- the function of various types of biotreatment systems (e.g., solid wastes, hazardous wastes, wastewater treatment, soil reclamation, treatment of airborne contaminants)
- design considerations in the application each.

Process/Skill Questions

- What are the key characteristics of biotreatment systems?
- How does the method of biotreatment affect the design of the system?
- What biotechnology techniques are used in biotreatment systems?
- How can biotreatment systems benefit the environment?
- What is the current public perception of biotreatment systems?
- How has the lack of biotreatment systems in underdeveloped countries affected the environment?

ITEEA National Standards

1. The Characteristics and Scope of Technology

TSA Competitive Events

Technology Bowl (Written and Oral)

Task Number 68

Examine the potential benefits of biological controls in plant and animal systems.

Definition

Examination should

- include explanations of plant structures (e.g., photoreceptors) and animal structures (e.g., the endocrine system) that contribute to biological control systems in those organisms
- distinguish between naturally occurring controls and modified systems.

Process/Skill Questions

- What basic control mechanisms are found in plant systems?
- What are the components of a control system in an animal?
- How can naturally occurring plant and animal control systems be beneficial to the environment?
- What alterations can be made to plant and animal control systems?
- How can biotechnology be used to positively affect plant and animal biocontrol systems?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

5. The Effects of Technology on the Environment

TSA Competitive Events

Biotechnology Design

Task Number 69

Design a bioremediation system.

Definition

Design should include a portfolio, drawings, model, and presentation of a bioremediation system. Student commentary on the design should include a distinction between bioremediation (i.e., the use of living organisms or their products to degrade waste into less-toxic or nontoxic products) and biore restoration (i.e., the use of living organisms or their products to return an environment to its original state).

Process/Skill Questions

- What are examples of bioremediation systems?
- What is the difference between bioremediation and biore restoration?
- What are some circumstances when one system may be chosen over the other?
- How can a bioremediation system positively and/or negatively affect the environment?

ITEEA National Standards

1. The Characteristics and Scope of Technology

TSA Competitive Events

Biotechnology Design

Engineering Design

Task Number 70

Plan a biore restoration system.

Definition

Plan should include a portfolio, drawings, model, and presentation of a biore restoration system. Plan should also include a distinction between bioremediation and biore restoration.

Process/Skill Questions

- What are examples of bioremediation systems?
- Why is bioremediation considered a biotechnology?
- What biological processes are involved in bioremediation?
- Why is it necessary to understand the biological processes involved when designing bioremediation systems?

ITEEA National Standards

8. The Attributes of Design

TSA Competitive Events

Biotechnology Design

Engineering Design

Task Number 71

Demonstrate the use of biotechnology to restore or remediate contaminated environments.

Definition

Demonstration should include the design, application, and evaluation of a bioremediation or bioremediation system.

Process/Skill Questions

- What types of environmental contamination can be rectified using bioremediation?
- What design constraints are encountered in the design of either a bioremediation or bioremediation system?
- What techniques are used to assess the effectiveness of bioremediation or bioremediation systems?
- How does the current public perception affect the use of biotechnology for bioremediation or bioremediation?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

5. The Effects of Technology on the Environment

TSA Competitive Events

Biotechnology Design

Examining the Role of Biotechnology in Agriculture

Task Number 72

Demonstrate various procedures used with tissue cultures.

Definition

Demonstration should include

- techniques for collection, storage, multiplication, and transportation of tissue-cultured plants
- data tracking to ensure plant identification.

Process/Skill Questions

- What is the importance of aseptic technique in tissue culture?
- What types of cells can be grown using tissue culture techniques?
- How is specimen collection accomplished in tissue culture?
- What is the advantage of growing cells through tissue culture?
- How can cells grown using tissue culture be manipulated using biotechnology techniques?
- What is the advantage of the multiplication stage in increasing plant numbers?
- How does the federal Plant Variety Protection Act (PVPA) affect tissue culture?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

Task Number 73

Analyze social implications of biotechnology in agriculture.

Definition

Analysis should include

- the ways biotechnology has accelerated changes in the field of agriculture throughout history and contributed to advanced research in other fields
- a description of the process and effects of the social transition from an agrarian society to a technology state.

Process/Skill Questions

- How has public, scientific, and corporate awareness affected biotechnology?
- What have been the major positive and negative social effects of biotechnology in agriculture?
- What is the GMO project, and what is its effect on society in the U.S.?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Biotechnology Design

Essays on Technology

Task Number 74

Identify microbial applications in agriculture.

Definition

Identification should include activities in which microbial applications are used as change agents in agricultural processes.

Process/Skill Questions

- What is a microbe?
- What is a microbe's traditional role in nature?
- How can a microbe be used as a change agent?
- What are the steps in using microbes as change agents?
- Which categories of microbes are used for which alterations in life processes?

ITEEA National Standards

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Biotechnology Design

Task Number 75

Summarize the role of biotechnology in crop modification.

Definition

Summary should be made by examining the

- production and use of biodegradable pesticides, herbicide-resistant crops and fertilizers
- development of plant byproducts.

Process/Skill Questions

- What are some examples of genetically modified organisms that are used to support crop production?
- What advantages do these genetically modified crops have over the wild-type crops?
- What innovations are the result of plant modification?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Biotechnology Design

Task Number 76

Identify factors that jeopardize food safety.

Definition

Identification should include factors that prevent and cause food spoilage and methods of processing, storing, and transporting foods.

Process/Skill Questions

- What steps are taken in food processing to meet safety regulations?
- What regulations and agencies govern food safety guidelines?
- What are the consequences of poor food processing, storage, and transportation?
- What are some causes of food spoilage?
- What is the rate of food-borne illnesses in the U.S.?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

Task Number 77

Examine advances of biotechnology in food science.

Definition

Examination should include biotechnological advances in food science, such as

- processing techniques (e.g., fermentation and irradiation)
- preservation methods (e.g., freeze drying)
- storage enhancers (e.g., food additives and preservatives).

Process/Skill Questions

- What are examples of advances in food science?
- What role has biotechnology played in food science advances?
- How can biotechnological advances in food science affect global food supplies?

ITEEA National Standards

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Biotechnology Design

Digital Video Production

Essays on Technology

Exploring Bioprocessing

Task Number 78

Define *bioprocessing*.

Definition

Definition should include that bioprocessing is the use of biological materials to carry out a process, such as bioprocessing techniques to develop

- specialty chemicals
- new drugs
- alternative fuels
- feedstocks
- biopolymers
- bioremediation.

Process/Skill Questions

- What are biopolymers?
- What is bioremediation?
- What are some examples of products made through biotechnology that are currently used for bioremediation?
- How are alternative fuels and feedstocks produced using bioprocessing?
- How can these alternative products affect global society?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Biotechnology Design

Technology Bowl (Written and Oral)

Task Number 79

Describe the process of fermentation.

Definition

Description should include

- agricultural products (e.g., beer, wine, bread)
- industrial products (e.g., ethanol, butanol, acetone)
- medical products (e.g., antibiotics, antiseptics, anti-inflammatories, anticoagulants, antidepressants, vasodilators).

It should also focus on the generation of energy by the breakdown of organic compounds (aerobic and anaerobic microorganisms).

Process/Skill Questions

- How long and in what contexts has the fermentation process been used?
- What conditions must exist for these processes to take place?

- What steps are necessary for fermentation to take place?
- How are the final products created from fermentation purified?

ITEEA National Standards

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Biotechnology Design

Technology Bowl (Written and Oral)

Task Number 80

Prepare a product generated from bioprocessing.

Definition

Preparation should include use of safety practices (e.g., Clinical Laboratory Improvement Amendment of 1988 [CLIA] guidelines), standard operating procedures, sterilization, and correct disposal of hazardous waste.

Process/Skill Questions

- What are examples of bioprocessed products?
- How are bioprocessed products used?
- What equipment is used in bioprocessing?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Biotechnology Design

Engineering Design

Task Number 81

Describe genetic engineering applications used in bioprocessing.

Definition

Description should include

- genetic applications in designer drugs
- genetically modified organisms (GMOs)
- bioremediation
- alternative fuels
- biopolymers.

Process/Skill Questions

- What are some examples of genetic engineering applications?
- What are some examples of ethical controversies surrounding genetic engineering? Why are they important?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Biotechnology Design

Engineering Design

Scientific and Technical Visualization (SciVis)

Technology Bowl (Written and Oral)

Task Number 82

Demonstrate the application of microbes in bioprocessing.

Definition

Demonstration should include use of safety practices (e.g., Clinical Laboratory Improvement Amendment of 1988 [CLIA] guidelines), standard operating procedures, sterilization, and correct disposal of hazardous waste.

Process/Skill Questions

- What are examples of microbes used in bioprocessing?
- What are examples of end-products of bioprocessing?
- How are these end-products purified?

ITEEA National Standards

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Biotechnology Design

Task Number 83

Describe the social and environmental effects of bioprocessing.

Definition

Description should address both positive and negative effects, including actual foreseen and unforeseen effects on society.

Process/Skill Questions

- Who might benefit from bioprocessing, and how?
- What are common misconceptions regarding bioprocessing? How can these misconceptions be addressed?
- What are the potential risks or dangers of bioprocessing?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

5. The Effects of Technology on the Environment

TSA Competitive Events

Biotechnology Design

Task Number 84

Perform separation and purification techniques.

Definition

Performance should include use of safety procedures (e.g., Clinical Laboratory Improvement Amendment of 1988 [CLIA] guidelines), standard operating procedures, sterilization, and correct disposal of hazardous waste. Techniques include filtration, chromatography, and solvent extraction.

Process/Skill Questions

- What is the purpose of separation and purification in bioprocessing?
- What products are produced through separation and purification techniques?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

TSA Competitive Events

Biotechnology Design

Task Number 85

Illustrate the design of bioprocessing systems.

Definition

Illustration should include the design process and standardized bioprocessing techniques.

Process/Skill Questions

- What are the steps in the design process?
- What are examples of bioprocessing techniques?
- Why are processing design techniques important?

ITEEA National Standards

11. Apply the Design Processes

8. The Attributes of Design

TSA Competitive Events

Biotechnology Design

Engineering Design

Examining the Role of Biotechnology in Medicine

Task Number 86

Identify the influence of biotechnology on medicine.

Definition

Identification should include historical, societal, cultural, and economic effects of biotechnology in the medical fields.

Process/Skill Questions

- What medical discoveries would be categorized under biotechnology as opposed to biomedical science?
- How has biotechnology in medicine improved society?

ITEEA National Standards

13. Assess the Impact of Products and Systems

14. Medical Technologies

TSA Competitive Events

Technology Bowl (Written and Oral)

Task Number 87

Describe the ethical, legal, and social implications of biomedicine.

Definition

Description should

- address the ethical, legal, and social effects of biomedicine throughout history
- include the ethical decision-making processes involving governmental influence on biomedical research.

Process/Skill Questions

- What are the positive and negative effects of genetic selection, gene therapy, and cloning?
- What are examples of negative effects of biomedicine?
- How is legislation developed and influenced by biomedicine?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Essays on Technology

Task Number 88

Explain vaccine (i.e., immunology) research and development.

Definition

Explanation should include current information on the contributions of biotechnology to the development and improvement of vaccines.

Process/Skill Questions

- How does industry develop new vaccines?
- How can biotechnology improve the effectiveness of vaccines?
- How can biotechnology contribute to the creation of new vaccines against diseases that currently do not have any vaccine available?

ITEEA National Standards

14. Medical Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Essays on Technology

Technology Bowl (Written and Oral)

Task Number 89

Describe the effects of molecular research on society.

Definition

Description should

- take into account ethical, legal, and social issues
- reflect an understanding that molecular research includes but is not limited to cellular manipulation of living organisms
- reflect a basic grasp of the process of cellular manipulation.

Process/Skill Questions

- How have materials, processes, and tools been developed for molecular research?
- What is the goal of molecular research?
- What is the outcome of molecular research?
- How can cells be manipulated?
- What biomedical treatments are being researched?

ITEEA National Standards

13. Assess the Impact of Products and Systems

14. Medical Technologies

15. Agricultural and Related Biotechnologies

Task Number 90

Identify emerging healthcare technologies.

Definition

Identification should include trends in biomedical diagnostic tools, treatment processes, and genetic materials.

Process/Skill Questions

- What are microarrays, and how do they work?
- How will microarrays affect diagnosis?
- What are the new methods of treatment in genetics and cellular research?
- How do emerging healthcare technologies affect a patient's quality of life?
- What new healthcare technologies are being developed as a result of advances in agriculture, biotechnology, and medicine?
- How can viruses be used to carry genes into cells as preventive medicine?

- How are designer immune drugs being used to treat cancer on an individual basis?
- How are these anti-cancer treatments developed?

ITEEA National Standards

14. Medical Technologies

6. The Role of Society in the Development and Use of Technology

Task Number 91

Explain the applications of genetics in pharmacology.

Definition

Explanation should include major contributions of genetics to pharmacology, as well as the effect of pharmacology on biomedicine.

Process/Skill Questions

- What are designer drugs?
- How does a drug affect a patient and treatment?
- What are the positive and negative effects of genetic applications in pharmacology on a patient?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

Task Number 92

Describe the effects of biotechnology on preventive healthcare.

Definition

Description should include examples of biotechnology-related ethical, legal, and social issues in preventive healthcare, as well as new advances in the preventive healthcare field.

Process/Skill Questions

- How has the Human Genome Project (HGP) impacted immunology?
- What percentage of the human genome actually codes for functioning genes?
- How have society and governmental influences affected preventive healthcare?
- What are basic preventive healthcare processes, and what is their relation to biomedicine?

ITEEA National Standards

13. Assess the Impact of Products and Systems

4. The Cultural, Social, Economic, and Political Effects of Technology

5. The Effects of Technology on the Environment

TSA Competitive Events

Digital Video Production

Investigating Forensics

Task Number 93

Define *forensic science*.

Definition

Definition should explain that forensic science is science that is used in the court system. Biotechnological aspects include DNA testing, paternity testing, serology testing, and special applications in wildlife/species determination.

Process/Skill Questions

- What is the purpose of forensic science?
- What are the processes involved with identifying a person through DNA analysis?
- When did the forensic use of DNA analysis first begin? How has it evolved over the years?

- What is serology testing? How has it evolved over the years?
- What role does DNA testing play in the determination of new species and wildlife forensics?
- What resources offer information about forensic science in the criminal, medical, and biological fields?
- What techniques are used in forensic DNA analysis to amplify the DNA and improve the outcome of the analysis?

ITEEA National Standards

1. The Characteristics and Scope of Technology

14. Medical Technologies

15. Agricultural and Related Biotechnologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Biotechnology Design

Technology Bowl (Written and Oral)

Task Number 94

Describe situations in which medical forensics can be used.

Definition

Description should include situations such as determining paternity, cause of death, effects of earlier treatments of diseases, and efficacy of drugs.

Process/Skill Questions

- What are the types and purposes of paternity tests for humans and animals?
- What are some of the tests used to determine cause of death?
- How can biological forensic evidence be collected and protected?
- How can the study of DNA analysis affect future treatments of disease?
- How has the use of commercially available kits for ethnic DNA analysis affected the study of DNA in society?

- What are the ethical dilemmas involved with the ever-growing DNA databases?

ITEEA National Standards

14. Medical Technologies

Task Number 95

Describe situations in which forensic science can be used in criminal investigations.

Definition

Description may include gathering and preserving evidence related to a criminal act. Situations may include those involving ballistics, terrorist acts, presence of suspect materials (e.g., anthrax), drowning, entomology, plant material used as evidence, accident scenes, forensic nursing (e.g., sexual assault/rape kits), and other cases involving law enforcement officers or medical examiners.

Process/Skill Questions

- What types of evidence may be collected from a crime scene?
- How does the type of crime determine the evidence gathered?
- What steps are involved in gathering and preserving evidence from a crime scene?
- What evidence suggests a criminal vs. an accidental act?
- What skills are important to have as a team member (whether law enforcement, medical professionals, scientists, government agencies, or media) in criminal forensics?
- How does television's portrayal of forensic science influence society's perception of the field?

ITEEA National Standards

14. Medical Technologies

Task Number 96

Describe situations in which biological forensic science can be used.

Definition

Description should include a definition of *biological forensic science*. Situations may include those involving any living organisms (e.g., disruptions in plant and animal life cycles, endangered species, extinct species, plant and animal mutations, and animal habitat degradation).

Process/Skill Questions

- How would one describe the interrelationship of criminal, medical, and biological forensic sciences?
- What basic skills are needed to collect evidence for biological forensics? Why is each skill important?
- How and where is biological forensic evidence processed?
- In what recent events have biological forensics been used? What effect did they have?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

Task Number 97

Demonstrate the basic instrumentation used in DNA analysis for forensic purposes.

Definition

Demonstration should include

- DNA extraction from living tissue
- pipetting technique
- gel electrophoresis.

Process/Skill Questions

- What are the primary types of instruments and equipment used in forensic science?
- What purpose do the instruments serve?
- What safety practices are important when using the instruments of forensic science?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

2. The Core Concepts of Technology

TSA Competitive Events

Engineering Design

Understanding Biomedical Engineering

Task Number 98

Define *bioengineering*.

Definition

Definition should explain that bioengineering is the design and manipulation of materials and organisms to create new products for medical, agricultural, and engineering applications.

Process/Skill Questions

- What are some examples of bioengineered products in the fields of medicine, agriculture, and engineering?
- What are the steps in the engineering design process?
- What are some of the ethical and legal issues associated with bioengineering?

ITEEA National Standards

1. The Characteristics and Scope of Technology

14. Medical Technologies

15. Agricultural and Related Biotechnologies

2. The Core Concepts of Technology

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Biotechnology Design

Technology Bowl (Written and Oral)

Task Number 99

Identify uses of nanobiotechnology.

Definition

Identification should include nanobiotechnology applications in medicine, agriculture, and engineering.

Process/Skill Questions

- What is the history of nanobiotechnology?
- How do patients benefit from tools fabricated by nanobiotechnology? How do farmers benefit? Engineers? The American consumer?

ITEEA National Standards

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

Biotechnology Design

Task Number 100

Identify examples of biowarfare.

Definition

Identification should include

- the history of biowarfare
- applications of biowarfare
- circumstances surrounding the use of biowarfare
- the use of personal protective equipment (PPE).

Process/Skill Questions

- What is the historical development of biowarfare?
- Why and how is PPE used in biowarfare?
- What international laws govern biowarfare?
- Why is a knowledge of biotechnology important for military leaders? For other military personnel? For civilians?

ITEEA National Standards

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

Technology Bowl (Written and Oral)

Task Number 101

Design and produce a biomechanism.

Definition

Design and production should include a portfolio (e.g., research, possible solutions, experimentation) and a model of a biomechanism.

Process/Skill Questions

- What types of human problems can biomechanisms solve?
- How can biomechanisms be designed and produced?
- How does society benefit from the development of biomechanisms?

ITEEA National Standards

11. Apply the Design Processes

12. Use and Maintain Technological Products and Systems

TSA Competitive Events

Biotechnology Design

Engineering Design

Examining Social Aspects and Ethics of Biotechnology

Task Number 102

Define *bioethics*.

Definition

Definition should include the standard description of ethics and the relationship of biotechnology to ethics.

Process/Skill Questions

- Why does the study of biotechnology require the study of ethics?
- What are prominent ethical issues raised by biotechnology?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

Biotechnology Design

Essays on Technology

Extemporaneous Presentation

Task Number 103

Assess implications of biotechnology, including gene therapy, patenting of living tissue, and cloning.

Definition

Assessment should include

- historical effects (e.g., animal husbandry, seed modification)
- current effects (e.g., gene therapy, patenting of living tissue, cloning)
- positive and negative effects.

Process/Skill Questions

- How has society benefited from biotechnology?
- How has biotechnology been affected by society?
- What is gene therapy meant to do?
- What is cloning?
- How and why are patents given to living tissue products and gene products?

ITEEA National Standards

13. Assess the Impact of Products and Systems

TSA Competitive Events

Biotechnology Design

Task Number 104

Differentiate among ethical principles that reflect social, religious, economic, and political perspectives.

Definition

Differentiation should be made among ethical principles reflected in social, religious, economic, and political segments of society.

Process/Skill Questions

- How are ethics different from laws?
- Why are the different principles of ethics essential?
- Why are there differences in ethical principles from one person or group to another?
- Whose ethics should guide biotechnology? Why?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Essays on Technology

Task Number 105

Identify regulations that affect biotechnology.

Definition

Identification should include

- legislation and safety guidelines
- ways that private and government organizations and business and industry influence the regulation of biotechnology.

Process/Skill Questions

- What are some of the regulatory agencies/organizations that affect biotechnology? How do they affect it?

- What do these regulatory agencies/organizations stand to benefit from regulating biotechnology?
- What are the advantages and disadvantages of biotechnology regulations from the consumer's perspective?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

Essays on Technology

SOL Correlation by Task

39	Define <i>biotechnology</i> .	English: 10.3, 11.3, 12.3 History and Social Science: VUS.14, WG.17, WHII.14
40	Give examples of biotechnology milestones.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.13, VUS.13, VUS.14, WG.7, WG.8, WG.10, WG.11, WG.12, WHII.6, WHII.8
41	Describe social implications of biotechnology.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.9, GOVT.15, VUS.13, VUS.14, WG.6, WHII.13, WHII.14 Mathematics: PS.1*, PS.7*, PS.11* Science: BIO.5
42	Describe technology transfer in biotechnology.	History and Social Science: VUS.13, VUS.14
43	Identify careers related to biotechnology.	English: 10.5, 10.8, 11.5, 11.8, 12.5, 12.8
44	Demonstrate understanding of required safety practices and procedures in the classroom and laboratory environment.	History and Social Science: VUS.8, VUS.13, VUS.14, WHII.8 Science: BIO.1, CH.1

45	Use the scientific method and the technological/engineering method to solve biotechnology problems.	English: 10.3, 10.5, 10.8, 11.3, 11.5, 11.8, 12.3, 12.5, 12.8 History and Social Science: WHII.4 Mathematics: A.8, A.9, AFDA.3, AFDA.8, AII.9, PS.1*, PS.2*, PS.3*, PS.4*, PS.8*, PS.10* Science: BIO.1, CH.1, PH.3, PH.4
46	Analyze data generated from lab activities.	English: 10.5, 10.8, 11.5, 11.8, 12.5, 12.8 History and Social Science: WHII.4 Mathematics: A.4, A.8, A.9, AFDA.3, AFDA.8, AII.3, AII.9, PS.1*, PS.2*, PS.3*, PS.4*, PS.8* Science: BIO.1, CH.1, PH.3
47	Explain the roles of sciences applicable to biotechnology, including organic chemistry, biochemistry, and microbiology.	English: 10.5, 11.5, 12.5 Science: BIO.2, CH.6
48	Prepare buffer stock solutions and reagents.	Mathematics: A.1, A.4, AII.3 Science: CH.4
49	Explain the structure and cellular function of organic macromolecules.	English: 10.5, 11.5, 12.5 History and Social Science: WHII.4 Science: BIO.2
50	Analyze how organic macromolecules are manipulated and detected, using biotechnological tools.	English: 10.5, 11.5, 12.5 Science: BIO.1
51	Explain the function of carbohydrates and lipids.	English: 10.5, 11.5, 12.5 Science: BIO.2
52	Differentiate among the types of proteins found in organisms.	English: 10.5, 11.5, 12.5
53	Explain the basic principles of protein utilization in organisms.	English: 10.5, 11.5, 12.5 Science: BIO.5
54	Explain the advantages of protein utilization in organisms.	English: 10.5, 11.5, 12.5

		Mathematics: AFDA.1, AFDA.3, AII.7, AII.9, PS.8*, PS.11* Science: BIO.4, BIO.7, BIO.8
55	Illustrate the function or use of an enzyme, using a prototype or model.	Science: BIO.2
56	Define <i>genetic engineering</i> .	English: 10.3, 11.3, 12.3 History and Social Science: VUS.14, WG.17, WHII.14 Science: BIO.5
57	Develop a timeline of genetic engineering milestones.	English: 10.5, 10.8, 11.5, 11.8, 12.5, 12.8 History and Social Science: GOVT.9, GOVT.15, VUS.3, VUS.6, VUS.13, VUS.14, WHI.1, WHI.2, WHI.3, WHI.4, WHI.5, WHI.8, WHI.9, WHI.11, WHI.12, WHI.13, WHII.1, WHII.2, WHII.5, WHII.6, WHII.7, WHII.13, WHII.14 Science: BIO.1, BIO.5
58	Model deoxyribonucleic acid (DNA).	History and Social Science: WHII.4 Science: BIO.5
59	Assess the importance of the genetic information contained in DNA.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WG.17, WHII.14 Science: BIO.5
60	Describe the function of DNA, ribonucleic acid (RNA), and protein in living cells.	History and Social Science: WHII.4 Science: BIO.5
61	Demonstrate how the structure of DNA influences its function, analysis, and manipulation.	History and Social Science: WHII.4 Science: BIO.5
62	Demonstrate how manipulation of nucleic acids through genetic engineering alters the function of proteins and subsequent cellular processes.	Science: BIO.1, BIO.5
63	Explain how genetic engineering is used in plants, animals, and medicine.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WG.17, WHII.14

64	Explain the importance of genetic mapping.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WG.17, WHIL.14 Science: BIO.5
65	Analyze social implications of genetic engineering.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.9, GOVT.15, VUS.3, VUS.6, VUS.13, VUS.14, WHIL.13, WHIL.14
66	Assess the social implication of environmental quality management.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.9, GOVT.15, VUS.13, VUS.14, WG.14, WG.15, WG.17, WHIL.13, WHIL.14
67	Investigate biotreatment systems.	English: 10.5, 10.8, 11.5, 11.8, 12.5, 12.8 History and Social Science: VUS.14, WG.17, WHIL.14
68	Examine the potential benefits of biological controls in plant and animal systems.	English: 10.5, 11.5, 12.5
69	Design a bioremediation system.	English: 10.1, 10.5, 10.6, 10.7, 11.1, 11.5, 11.6, 11.7, 12.1, 12.5, 12.6, 12.7 History and Social Science: VUS.14, WG.17, WHIL.14 Science: BIO.1
70	Plan a bioremediation system.	English: 10.1, 10.5, 10.6, 10.7, 11.1, 11.5, 11.6, 11.7, 12.1, 12.5, 12.6, 12.7 History and Social Science: VUS.14, WG.17, WHIL.14 Science: BIO.1
71	Demonstrate the use of biotechnology to restore or remediate contaminated environments.	History and Social Science: VUS.14, WG.17, WHIL.14
72	Demonstrate various procedures used with tissue cultures.	
73	Analyze social implications of biotechnology in agriculture.	English: 10.5, 11.5, 12.5

		History and Social Science: GOVT.9, GOVT.15, VUS.13, VUS.14, WG.14, WG.15, WG.17, WHIL.13, WHIL.14
74	Identify microbial applications in agriculture.	English: 10.5, 11.5, 12.5 Science: BIO.3, BIO.7
75	Summarize the role of biotechnology in crop modification.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WG.17, WHIL.14 Science: BIO.5, BIO.7
76	Identify factors that jeopardize food safety.	English: 10.5, 11.5, 12.5
77	Examine advances of biotechnology in food science.	History and Social Science: WHI.3, WHI.12
78	Define <i>bioprocessing</i> .	English: 10.3, 11.3, 12.3 History and Social Science: VUS.14, WG.17, WHIL.14
79	Describe the process of fermentation.	English: 10.5, 11.5, 12.5 History and Social Science: WHI.3, WHI.4 Science: BIO.2
80	Prepare a product generated from bioprocessing.	History and Social Science: VUS.14, WG.17, WHIL.14
81	Describe genetic engineering applications used in bioprocessing.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WG.17, WHIL.14 Science: BIO.5
82	Demonstrate the application of microbes in bioprocessing.	
83	Describe the social and environmental effects of bioprocessing.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.9, GOVT.15, VUS.13, VUS.14, WG.14, WG.15, WG.17, WHIL.13, WHIL.14
84	Perform separation and purification techniques.	Science: CH.1
85	Illustrate the design of bioprocessing systems.	
86	Identify the influence of biotechnology on medicine.	English: 10.5, 11.5, 12.5

		History and Social Science: GOVT.9, GOVT.15, VUS.13, VUS.14, WHII.13, WHII.14
87	Describe the ethical, legal, and social implications of biomedicine.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.9, GOVT.15, VUS.13, VUS.14, WHII.13, WHII.14
88	Explain vaccine (i.e., immunology) research and development.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.8, VUS.13, VUS.14, WG.17, WHII.8, WHII.14 Science: BIO.3
89	Describe the effects of molecular research on society.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.9, GOVT.15, VUS.13, VUS.14, WHII.13, WHII.14 Science: BIO.5
90	Identify emerging healthcare technologies.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.9, GOVT.15, VUS.3, VUS.6, VUS.13, VUS.14, WHII.13, WHII.14
91	Explain the applications of genetics in pharmacology.	English: 10.5, 11.5, 12.5 Science: BIO.5
92	Describe the effects of biotechnology on preventive healthcare.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.9, GOVT.15, VUS.13, VUS.14, WHII.13, WHII.14
93	Define <i>forensic science</i> .	English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5 History and Social Science: VUS.14, WG.17, WHII.14 Science: BIO.5
94	Describe situations in which medical forensics can be used.	English: 10.5, 11.5, 12.5
95	Describe situations in which forensic science can be used in criminal investigations.	English: 10.5, 11.5, 12.5

96	Describe situations in which biological forensic science can be used.	English: 10.5, 11.5, 12.5
97	Demonstrate the basic instrumentation used in DNA analysis for forensic purposes.	English: 10.5, 11.5, 12.5
98	Define <i>bioengineering</i> .	English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5 History and Social Science: VUS.14, WG.17, WHII.14
99	Identify uses of nanobiotechnology.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WG.17, WHII.14
100	Identify examples of biowarfare.	History and Social Science: GOVT.9, GOVT.15, VUS.13, VUS.14, WHII.12, WHII.13, WHII.14
101	Design and produce a biomechanism.	English: 10.1, 10.5, 10.8, 11.1, 11.5, 11.8, 12.1, 12.5, 12.8 History and Social Science: VUS.14, WG.17, WHII.14 Science: BIO.1
102	Define <i>bioethics</i> .	English: 10.3, 11.3, 12.3 History and Social Science: VUS.14, WG.17, WHII.14
103	Assess implications of biotechnology, including gene therapy, patenting of living tissue, and cloning.	History and Social Science: GOVT.1, GOVT.9, GOVT.15, VUS.13, VUS.14, WHII.12, WHII.13, WHII.14 Science: BIO.5
104	Differentiate among ethical principles that reflect social, religious, economic, and political perspectives.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.1, GOVT.3, GOVT.9, GOVT.15, GOVT.16
105	Identify regulations that affect biotechnology.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.9

Entrepreneurship Infusion Units

Entrepreneurship Infusion Units may be used to help students achieve additional, focused competencies and enhance the validated tasks/competencies related to identifying and starting a

new business venture. Because the unit is a complement to certain designated courses and is not mandatory, all tasks/competencies are marked “optional.”

Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- Agricultural Biotechnology Assessment
- College and Work Readiness Assessment (CWRA+)
- National Career Readiness Certificate Assessment
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: *A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.*

- Applied Agricultural Concepts (8072/18 weeks)
- Applied Agricultural Concepts (8073/36 weeks)
- Biological Applications in Agriculture (8086/36 weeks)
- Biomedical Engineering (8467/36 weeks)
- Biomedical Technician (8347/36 weeks)
- Forensic Technology (8409/36 weeks)
- Medical Laboratory Technology I (8377/36 weeks)
- Medical Laboratory Technology II (8378/36 weeks)

Career Cluster: Agriculture, Food and Natural Resources	
Pathway	Occupations
Animal Systems	Animal Breeder, Husbandry Animal Scientist
Environmental Service Systems	Environmental Compliance Inspector Environmental Sampling and Analysis Technician Toxicologist
Food Products and Processing Systems	Biochemist Food Scientist
Plant Systems	Botanist Forest Geneticist Plant Breeder/ Geneticist
Power, Structural, and Technical Systems	Agricultural Engineer

Career Cluster: Health Science	
Pathway	Occupations
Biotechnology Research and Development	Biochemist
Diagnostics Services	Medical, Clinical Laboratory Technician
Health Informatics	Epidemiologist
Support Services	Environmental Sampling and Analysis Technician Medical, Clinical Laboratory Technologist

Career Cluster: Science, Technology, Engineering and Mathematics	
Pathway	Occupations
Engineering and Technology	Agricultural Engineer Biomedical Engineer Environmental Engineer
Science and Mathematics	Biologist Environmental Scientist