

# Biotechnology Foundations in Health and Medical Sciences

8344 36 weeks

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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 DNA analysis, to medicine,

biomechanical systems, 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.

| 8344                                    | Tasks/Competencies   |  |
|---|--|--|
| Exploring Foundations in Biotechnology  |  |  |
| ⊕                                       | Define <i>biotechnology</i> .  |  |
| ⊕                                       | Give examples of biotechnology milestones.   |  |
| ⊕                                       | Describe social impacts of biotechnology.  |  |
| ⊕                                       | Describe technology transfer in biotechnology.   |  |
| ⊕                                       | Identify careers related to biotechnology.   |  |
| Preparing for Biotechnology Experiences |  |  |
| ⊕                                       | Demonstrate safe laboratory procedures.  |  |
| ⊕                                       | Use the scientific method and the technological/engineering method to solve biotechnology problems.                    |  |
| ⊕                                       | Analyze data generated from lab activities.  |  |
| Exploring Biochemistry                  |  |  |
| ⊕                                       | Explain the roles of sciences applicable to biotechnology including organic chemistry, biochemistry, and microbiology. |  |
| ⊕                                       | Explain the catalyzation process.  |  |
| ⊕                                       | Describe the characteristics and functions of enzymes.   |  |
| ⊕                                       | Identify applications for enzymes in an organism.  |  |
| ⊕                                       | Illustrate the function or use of an enzyme, using a prototype or model.   |  |

|   |   |  |
|---|---|--|
| <input checked="" type="radio"/>                          | Explain the basic principles of protein utilization in organisms.                             |  |
| <input checked="" type="radio"/>                          | Explain the advantages of protein utilization in organisms.                                   |  |
| <input checked="" type="radio"/>                          | Differentiate among the different types of proteins found in organisms.                       |  |
| <input checked="" type="radio"/>                          | Explain the function of carbohydrates.  |  |
| <input checked="" type="radio"/>                          | Explain the structure and cellular/function of organic macromolecules.                        |  |
| <input checked="" type="radio"/>                          | Analyze how organic macromolecules are manipulated and detected using biotechnological tools. |  |
| <b>Applying Biotechnology to the Environment</b>          |   |  |
| <input checked="" type="radio"/>                          | Assess the social impact of environmental quality management.                                 |  |
| <input checked="" type="radio"/>                          | Investigate the purpose and design of biotreatment systems.                                   |  |
| <input checked="" type="radio"/>                          | Examine the potential benefits of biological controls in plant and animal systems.            |  |
| <input checked="" type="radio"/>                          | Design a bioremediation system.   |  |
| <input checked="" type="radio"/>                          | Plan a biorestitution system.   |  |
| <input checked="" type="radio"/>                          | Demonstrate the use of biotechnology to restore or remediate contaminated environments.       |  |
| <b>Examining the Role of Biotechnology in Agriculture</b> |   |  |
| <input type="radio"/>                                     | Demonstrate various procedures used with tissue cultures.                                     |  |
| <input type="radio"/>                                     | Analyze social impacts of biotechnology in agriculture.                                       |  |
| <input type="radio"/>                                     | Identify microbial applications in agriculture.   |  |
| <input type="radio"/>                                     | Summarize the role of biotechnology in crop modification.                                     |  |
| <input type="radio"/>                                     | Identify factors that jeopardize food safety.   |  |
| <input type="radio"/>                                     | Examine advances of biotechnology in food science.  |  |
| <b>Exploring Bioprocessing</b>                            |   |  |
| <input checked="" type="radio"/>                          | Define <i>bioprocessing</i> .   |  |
| <input checked="" type="radio"/>                          | Describe the process of fermentation.   |  |

|   |  |  |
|---|--|--|
| +   | Prepare products generated from bioprocessing.                     |  |
| +   | Describe genetic engineering applications used in bioprocessing.   |  |
| +   | Demonstrate the application of microbes in bioprocessing.          |  |
| +   | Describe the social impacts of bioprocessing.                      |  |
| +   | Perform separation and purification techniques.                    |  |
| +   | Illustrate the design of bioprocessing systems.                    |  |
| Investigating Genetic Engineering               |  |  |
| +   | Define <i>genetic engineering</i> .                                |  |
| +   | Develop a historic timeline of genetic engineering milestones.     |  |
| +   | Assess the importance of the genetic information contained in DNA. |  |
| +   | Demonstrate techniques for genetic manipulation.                   |  |
| +   | Explain how genetic engineering is related to disease prevention.  |  |
| +   | Explain the importance of genetic mapping.                         |  |
| +   | Analyze social impacts of genetic engineering.                     |  |
| Examining the Role of Biotechnology in Medicine |  |  |
| +   | Identify the impacts biotechnology has on medicine.                |  |
| +   | Describe the ethical, legal, and social impacts of biomedicine.    |  |
| +   | Explain vaccine (immunology) research and development.             |  |
| +   | Describe the impacts of molecular research on society.             |  |
| +   | Identify emerging healthcare technologies.                         |  |
| +   | Explain the applications of genetics in pharmacology.              |  |
| +   | Describe the impacts of biotechnology on preventive healthcare.    |  |
| Investigating Forensics                         |  |  |
| +   | Define <i>forensic science</i> .                                   |  |

|  |  |
|--|--|
| +  | Describe situations in which medical forensics can be used.  |
| +  | Describe situations in which forensic science can be used in criminal investigations.                        |
| +  | Describe situations in which biological forensic science can be used.  |
| +  | Demonstrate the basic instrumentation used in DNA analysis for forensic purposes.                            |
| Understanding Bioengineering                         |  |
| +  | Define <i>bioengineering</i> .   |
| +  | Identify uses of nanobiotechnology.  |
| +  | Identify examples of biowarfare.   |
| +  | Design and produce a biomechanism.   |
| Examining Social Aspects and Ethics of Biotechnology |  |
| +  | Define <i>bioethics</i> .  |
| +  | Assess impacts of biotechnology (including gene therapy, patenting of living tissue, cloning).               |
| +  | Differentiate among ethical principles that reflect social, religious, economic, and political perspectives. |
| +  | Identify regulations that impact 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?

## **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)**

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## **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 increased the pace of breakthroughs in biotechnology?
- What are future applications of the human genome project? Of other genomes?

## **ITEEA National Standards**

### **7. The Influence of Technology on History**

#### **TSA Competitive Events**

##### **Biotechnology Design**

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## **Task Number 41**

### **Describe social impacts of biotechnology.**

#### **Definition**

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

#### **Process/Skill Questions**

- 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?
- What are historical examples of the social impacts of biotechnology decisions or events?
- What is the role of biotechnology in different countries?
- How are biotechnology research and development funded?
- What is the effect of marketing on 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**

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## **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 impacts 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**

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## **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
- Design
- Product development
- Manufacturing/production
- Teaching
- Genetics

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?

### **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**

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# **Preparing for Biotechnology Experiences**

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## **Task Number 44**

### **Demonstrate safe laboratory procedures.**

#### **Definition**

Demonstration should

- reflect a knowledge of general safety rules (e.g., those related to fire, electricity, infection prevention, transmission of diseases), aseptic technique, and industry-specified guidelines (e.g., Occupational Safety and Health Administration [OSHA] and Clinical Laboratory Improvement Amendment [CLIA])
- follow manufacturers' guidelines for equipment and material use
- include safety procedures related to the use and disposal of sharps, hazardous materials, 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?
- What are material safety data sheets (MSDS)? Why are they important?
- Why is documentation important to safety?

### **ITEEA National Standards**

#### **12. Use and Maintain Technological Products and Systems**

#### **TSA Competitive Events**

#### **Biotechnology Design**

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### **Task Number 45**

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

#### **Definition**

Use of the scientific method involves:

- observing
- classifying and sequencing
- communicating
- measuring
- predicting
- hypothesizing
- inferring

- defining, controlling, and manipulating variables in experimentation
- designing, constructing, and interpreting models
- interpreting, analyzing, and evaluating data.

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 solution.

### **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?
- Under what conditions would you use each 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

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

### **Process/Skill Questions**

- How are quality controls maintained?
- What would be the consequences of not maintaining quality controls?
- How are data standards identified?
- How and why are data collected from lab activities?
- How may the data be documented?
- How should data collection affect the desired analysis technique?
- How are data used to model biotechnical processes?

### **ITEEA National Standards**

**14. Medical Technologies**

**15. Agricultural and Related Biotechnologies**

### **TSA Competitive Events**

**Biotechnology Design**

**Engineering Design**

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## **Exploring Biochemistry**

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**Task Number 47**

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

### **Definition**

Explanation should include the roles of organic chemistry, biochemistry, and microbes in biotechnology.

### **Process/Skill Questions**

- What is the difference between basic organic chemistry and biochemistry?
- What basic chemical processes and terminology are involved in organic chemistry/biochemistry?
- How are microbes 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)**

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## **Task Number 48**

### **Explain the catalyzation process.**

#### **Definition**

Explanation should point out that catalyzation is a process that evolves, increasing the rate of speed in which chemical reactions are completed.

#### **Process/Skill Questions**

- How is the optimization of catalyzation important to industry?
- What factors can speed up the catalyzation process?

- How is the optimization of catalyzation important to the industry?

## **ITEEA National Standards**

### **13. Assess the Impact of Products and Systems**

#### **TSA Competitive Events**

#### **Technology Bowl (Written and Oral)**

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## **Task Number 49**

### **Describe the characteristics and functions of enzymes.**

#### **Definition**

Description should emphasize that enzymes

- are proteins in all living cells
- are catalytic molecules that speed up the rate of biological and chemical reactions
- aid in the breakdown of food particles into smaller compounds such as amino acids, simple sugars, glycerol, and fatty acids.

#### **Process/Skill Questions**

- What are the characteristics and functions of enzymes?
- How are enzymes used in making detergents and cleaning products?
- How are enzymes used in industrial settings?
- What is the effect of industrial enzyme use upon the environment?

## **ITEEA National Standards**

### **13. Assess the Impact of Products and Systems**

#### **TSA Competitive Events**

#### **Technology Bowl (Written and Oral)**

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## **Task Number 50**

### **Identify applications for enzymes in an organism.**

## **Definition**

Identification should include the fact that enzymes make a valuable contribution to living organisms by maintaining an internal balance of all bodily functions.

## **Process/Skill Questions**

- How is the enzyme regulated and maintained in an organism?
- What are the potential benefits involved in the utilization of the enzyme?
- What are some common enzymes?
- How are enzymes transported or stored throughout the organism?
- How does a living system provide for the life or growth requirements needed by an organism?

## **ITEEA National Standards**

### **12. Use and Maintain Technological Products and Systems**

#### **TSA Competitive Events**

##### **Technology Bowl (Written and Oral)**

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## **Task Number 51**

### **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. It 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?
- 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**

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## **Task Number 52**

### **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.

#### **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**

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## **Task Number 53**

### **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)**

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## **Task Number 54**

### **Differentiate among the different 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 different types of proteins?
- What are the functions of the different types of proteins?

## **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 55**

**Explain the function of carbohydrates.**

### **Definition**

Explanation should point out that carbohydrates form chains of polysaccharides (long chains of sugar molecules), which are essential building blocks for life.

### **Process/Skill Questions**

- What are the functions of carbohydrates in an organism?
- What are the types of carbohydrates?
- How are carbohydrates used in plant fungicide?

## **ITEEA National Standards**

**14. Medical Technologies**

**15. Agricultural and Related Biotechnologies**

## **TSA Competitive Events**

**Technology Bowl (Written and Oral)**

## **Task Number 56**

## **Explain the structure and cellular/function of organic macromolecules.**

### **Definition**

Explanation should

- include that there are four types of macromolecules: lipids, carbohydrates, proteins, and nucleic acids
- describe how current research and manipulation of carbohydrate molecules within the field of biochemistry have produced new carbohydrate molecules that can be designed specifically for innovative processes.

### **Process/Skill Questions**

- What are macromolecules?
- What are the types of macromolecules?
- What mechanisms (sensors and gauges) are used to monitor carbohydrates?

### **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**

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## **Task Number 57**

**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**

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# **Applying Biotechnology to the Environment**

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## **Task Number 58**

**Assess the social impact 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**

- How might current environmental issues associated with biotechnology be categorized?
- In which environmental issues is biotechnology 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**

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## **Task Number 59**

### **Investigate the purpose and design of biotreatment systems.**

#### **Definition**

Investigation should include

- 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?
- In what ways can biotreatment systems benefit the environment?
- 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)**

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## **Task Number 60**

### **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., 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?

#### **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**

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## **Task Number 61**

### **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 (the use of living organisms or their products to degrade waste into less-toxic or nontoxic products) and

bioremediation (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 bioremediation?
- What are some circumstances when one system may be chosen over the other?
- How can a bioremediation system positively and/or negatively impact the environment?

### **ITEEA National Standards**

#### **1. The Characteristics and Scope of Technology**

### **TSA Competitive Events**

**Biotechnology Design**  
**Engineering Design**

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## **Task Number 62**

### **Plan a bioremediation system.**

#### **Definition**

Plan should include a portfolio, drawings, model, and presentation of a bioremediation system. Plan should also include a distinction between bioremediation (the use of living organisms or their products to degrade waste into less-toxic or nontoxic products) and bioremediation (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?
- Why is bioremediation considered a biotechnology?
- 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**

## **Task Number 63**

### **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?

#### **ITEEA National Standards**

**14. Medical Technologies**

**15. Agricultural and Related Biotechnologies**

**5. The Effects of Technology on the Environment**

#### **TSA Competitive Events**

**Biotechnology Design**

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## **Examining the Role of Biotechnology in Agriculture**

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## **Task Number 64**

## **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?
- How is specimen collection accomplished in tissue culture?
- What is the advantage of the multiplication stage in increasing plant numbers?
- How does the federal Plant Variety Protection Act affect tissue culture?

### **ITEEA National Standards**

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

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## **Task Number 65**

## **Analyze social impacts 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 impacts of biotechnology in agriculture?

### **ITEEA National Standards**

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

### **TSA Competitive Events**

**Biotechnology Design  
Essays on Technology**

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## **Task Number 66**

### **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 microbes are used for which alterations in life processes?

### **ITEEA National Standards**

#### **15. Agricultural and Related Biotechnologies**

### **TSA Competitive Events**

**Biotechnology Design**

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## **Task Number 67**

### **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 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**

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## **Task Number 68**

### **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?

### **ITEEA National Standards**

#### **12. Use and Maintain Technological Products and Systems**

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## **Task Number 69**

### **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

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# Exploring Bioprocessing

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## Task Number 70

### 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?
- How are alternative fuels and feedstocks produced using bioprocessing?

### **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)**

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## **Task Number 71**

### **Describe the process of fermentation.**

#### **Definition**

Description should include

- agricultural products (beer, wine, bread)
- industrial products (ethanol, butanol, acetone)
- medical products (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?

## **ITEEA National Standards**

### **15. Agricultural and Related Biotechnologies**

#### **TSA Competitive Events**

**Biotechnology Design  
Technology Bowl (Written and Oral)**

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## **Task Number 72**

### **Prepare products 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  
Manufacturing Prototype**

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## **Task Number 73**

### **Describe genetic engineering applications used in bioprocessing.**

## **Definition**

Description should include

- genetic applications in designer drugs
- genetically modified organisms
- 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)**

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## **Task Number 74**

### **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?

## **ITEEA National Standards**

### **15. Agricultural and Related Biotechnologies**

#### **TSA Competitive Events**

##### **Biotechnology Design**

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## **Task Number 75**

### **Describe the social impacts of bioprocessing.**

#### **Definition**

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

#### **Process/Skill Questions**

- Who might benefit from bioprocessing, and how?
- What are common misconceptions of bioprocessing?
- 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**

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## **Task Number 76**

### **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. Examples 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**

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## **Task Number 77**

### **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**

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# Investigating Genetic Engineering

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## Task Number 78

### 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 are the building blocks of an organism's genome?
- How are genes introduced or eliminated from the genome of an organism using biotechnology techniques?

#### 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)

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## Task Number 79

### Develop a historic timeline of genetic engineering milestones.

#### Definition

Historic timeline should include major events in genetic engineering such as

- Mendel's discovery

- DNA modeling
- gene therapy
- cloning.

### **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?

### **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**

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## **Task Number 80**

### **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 direct the formation of proteins?
- How is gene expression a regulatory mechanism?
- How does DNA affect the genetic makeup of a living organism?

### **ITEEA National Standards**

- 14. Medical Technologies**
- 15. Agricultural and Related Biotechnologies**

## **TSA Competitive Events**

### **Essays on Technology**

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## **Task Number 81**

### **Demonstrate techniques for genetic manipulation.**

#### **Definition**

Demonstration may include the following techniques of DNA extraction:

- Centrifugation
- Precipitation
- Spooling

#### **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 the purpose of genetic manipulation?

#### **ITEEA National Standards**

**11. Apply the Design Processes**

**12. Use and Maintain Technological Products and Systems**

**14. Medical Technologies**

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## **Task Number 82**

### **Explain how genetic engineering is related to disease prevention.**

#### **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 83**

### **Explain the importance of genetic mapping.**

#### **Definition**

Explanation should include description 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 various 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)**

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## **Task Number 84**

### **Analyze social impacts of genetic engineering.**

#### **Definition**

Analysis should include

- ethical
- humanitarian
- economic
- 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?

#### **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**

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## **Examining the Role of Biotechnology in Medicine**

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## **Task Number 85**

## **Identify the impacts biotechnology has on medicine.**

### **Definition**

Identification should include historical, societal, cultural, and financial impacts of biotechnology in the medical fields.

### **Process/Skill Questions**

- What medical discoveries would be categorized under biotechnology as opposed to biomedicine?
- In what ways 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)**

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## **Task Number 86**

## **Describe the ethical, legal, and social impacts of biomedicine.**

### **Definition**

Description should

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

### **Process/Skill Questions**

- What are the positive and negative impacts of genetic selection, gene therapy, and cloning?
- What are examples of negative impacts 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**

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## **Task Number 87**

### **Explain vaccine (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?

#### **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)**

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## **Task Number 88**

### **Describe the impacts 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?
- In what ways 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**

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## **Task Number 89**

### **Identify emerging healthcare technologies.**

#### **Definition**

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

#### **Process/Skill Questions**

- How will microarrays affect diagnosis?
- What are the new methods of treatment in areas such as 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?

### **ITEEA National Standards**

**14. Medical Technologies**

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

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## **Task Number 90**

# **Explain the applications of genetics in pharmacology.**

## **Definition**

Explanation should include major contributions of genetics to pharmacology, as well as the impact 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 impacts of genetic applications in pharmacology on a patient?

## **ITEEA National Standards**

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

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## **Task Number 91**

# **Describe the impacts of biotechnology on preventive health care.**

## **Definition**

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

## **Process/Skill Questions**

- How has the Human Genome Project impacted immunology?
- How have society and governmental influences impacted preventive health care?
- 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**

# Investigating Forensics

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## Task Number 92

### 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?

#### 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)

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## **Task Number 93**

### **Describe situations in which medical forensics can be used.**

#### **Definition**

Description should include situations such as determining paternity, causes 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?

#### **ITEEA National Standards**

##### **14. Medical Technologies**

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## **Task Number 94**

### **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**

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## **Task Number 95**

### **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 you 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 impact did they have?

## **ITEEA National Standards**

### **14. Medical Technologies**

### **15. Agricultural and Related Biotechnologies**

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## **Task Number 96**

### **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**

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# **Understanding Bioengineering**

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## **Task Number 97**

### **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 field of medicine?  
Agriculture? 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)**

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## **Task Number 98**

**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**

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## **Task Number 99**

**Identify examples of biowarfare.**

### **Definition**

Identification should come from

- 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 are international laws that 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)**

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## **Task Number 100**

### **Design and produce a biomechanism.**

#### **Definition**

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

#### **Process/Skill Questions**

- What types of human problems can biomechanisms solve?
- What are the various ways biomechanisms can 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**

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# **Examining Social Aspects and Ethics of Biotechnology**

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## **Task Number 101**

**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**

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## **Task Number 102**

## **Assess impacts of biotechnology (including gene therapy, patenting of living tissue, cloning).**

### **Definition**

Assessment should include

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

### **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**

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## **Task Number 103**

### **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**

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## **Task Number 104**

### **Identify regulations that impact 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 impact biotechnology? How do they impact 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**

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## **SOL Correlation by Task**

|    |  |   |
|----|--|---|
| 39 | Define <i>biotechnology</i> .  | English: 10.3, 11.3, 12.3   |
| 40 | Give examples of biotechnology milestones.   | English: 10.5, 11.5, 12.5<br><br>History and Social Science:<br>WHI.1, WHI.3, WHI.4, WHII.1,<br>WHII.9  |
| 41 | Describe social impacts of biotechnology.  | English: 10.5, 11.5, 12.5<br><br>History and Social Science:<br>GOVT.15, VUS.1, WHII.1<br><br>Mathematics: PS.4*, PS.7*,<br>PS.11*<br><br>Science: BIO.5                      |
| 42 | Describe technology transfer in biotechnology.   |   |
| 43 | Identify careers related to biotechnology.   | English: 10.5, 10.8, 11.5, 11.8,<br>12.5, 12.8  |
| 44 | Demonstrate safe laboratory procedures.  | Science: BIO.1, CH.1  |
| 45 | Use the scientific method and the technological/engineering method to solve biotechnology problems.                    | Science: BIO.1, CH.1  |
| 46 | Analyze data generated from lab activities.  | English: 10.5, 10.8, 11.5, 11.8,<br>12.5, 12.8<br><br>Mathematics: A.4, A.8, A.9,<br>AFDA.3, AFDA.4, AFDA.8,<br>AII.3, AII.9, PS.1*, PS.2*, PS.3*<br><br>Science: BIO.1, CH.1 |
| 47 | Explain the roles of sciences applicable to biotechnology including organic chemistry, biochemistry, and microbiology. | Science: BIO.2, CH.6  |
| 48 | Explain the catalyzation process.  | Science: CH.3   |
| 49 | Describe the characteristics and functions of enzymes.   | English: 10.5, 11.5, 12.5<br><br>Science: BIO.2, CH.6   |
| 50 | Identify applications for enzymes in an organism.  | Science: BIO.1, BIO.2, BIO.3  |
| 51 | Illustrate the function or use of an enzyme, using a prototype or model.   | Science: BIO.2  |
| 52 | Explain the basic principles of protein utilization in organisms.  | Science: BIO.5  |
| 53 | Explain the advantages of protein utilization in organisms.  | Mathematics: AFDA.3, AFDA.4,<br>AII.7<br><br>Science: BIO.4, BIO.7, BIO.8   |

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| 54 | Differentiate among the different types of proteins found in organisms.                       |   |
| 55 | Explain the function of carbohydrates.  | Science: BIO.2  |
| 56 | Explain the structure and cellular/function of organic macromolecules.                        |   |
| 57 | Analyze how organic macromolecules are manipulated and detected using biotechnological tools. |   |
| 58 | Assess the social impact of environmental quality management.                                 | English: 10.5, 10.8, 11.5, 11.8, 12.5, 12.8<br><br>History and Social Science: GOVT.15, VUS.1, WHII.1 |
| 59 | Investigate the purpose and design of biotreatment systems.                                   |   |
| 60 | Examine the potential benefits of biological controls in plant and animal systems.            |   |
| 61 | Design a bioremediation system.   | Science: BIO.1  |
| 62 | Plan a biore restoration system.  | Science: BIO.1  |
| 63 | Demonstrate the use of biotechnology to restore or remediate contaminated environments.       |   |
| 64 | Demonstrate various procedures used with tissue cultures.                                     | Science: BIO.1  |
| 65 | Analyze social impacts of biotechnology in agriculture.                                       | History and Social Science: GOVT.15, VUS.1, WHII.1<br><br>Science: BIO.5                              |
| 66 | Identify microbial applications in agriculture.   | English: 10.5, 11.5, 12.5<br><br>Science: BIO.3, BIO.7  |
| 67 | Summarize the role of biotechnology in crop modification.                                     | English: 10.5, 11.5, 12.5<br><br>Science: BIO.5   |
| 68 | Identify factors that jeopardize food safety.   | English: 10.5, 11.5, 12.5   |
| 69 | Examine advances of biotechnology in food science.  |   |
| 70 | Define <i>bioprocessing</i> .   | English: 10.3, 11.3, 12.3   |
| 71 | Describe the process of fermentation.   | English: 10.5, 11.5, 12.5<br><br>Science: BIO.2   |
| 72 | Prepare products generated from bioprocessing.  | Science: CH.1   |
| 73 | Describe genetic engineering applications used in bioprocessing.                              | English: 10.5, 11.5, 12.5   |
| 74 | Demonstrate the application of microbes in bioprocessing.                                     | Science: BIO.1  |

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| 75 | Describe the social impacts of bioprocessing.                      | English: 10.5, 11.5, 12.5<br>History and Social Science:<br>GOVT.15, VUS.1, WHII.1     |
| 76 | Perform separation and purification techniques.                    | Science: BIO.1, CH.1   |
| 77 | Illustrate the design of bioprocessing systems.                    |  |
| 78 | Define <i>genetic engineering</i> .                                | Science: BIO.5   |
| 79 | Develop a historic timeline of genetic engineering milestones.     | History and Social Science:<br>WHI.1, WHII.1<br><br>Science: BIO.1, BIO.5              |
| 80 | Assess the importance of the genetic information contained in DNA. | English: 10.5, 11.5, 12.5<br><br>Science: BIO.5  |
| 81 | Demonstrate techniques for genetic manipulation.                   | Science: BIO.1, BIO.5  |
| 82 | Explain how genetic engineering is related to disease prevention.  |  |
| 83 | Explain the importance of genetic mapping.                         | English: 10.5, 11.5, 12.5<br><br>Science: BIO.5  |
| 84 | Analyze social impacts of genetic engineering.                     | History and Social Science:<br>GOVT.15, VUS.1  |
| 85 | Identify the impacts biotechnology has on medicine.                | History and Social Science:<br>GOVT.15, VUS.1, WHII.1                                  |
| 86 | Describe the ethical, legal, and social impacts of biomedicine.    | English: 10.5, 11.5, 12.5<br><br>History and Social Science:<br>GOVT.15, VUS.1, WHII.1 |
| 87 | Explain vaccine (immunology) research and development.             | English: 10.5, 11.5, 12.5<br><br>Science: BIO.3, BIO.5                                 |
| 88 | Describe the impacts of molecular research on society.             | English: 10.5, 11.5, 12.5<br><br>History and Social Science:<br>GOVT.15, VUS.1, WHII.1 |
| 89 | Identify emerging healthcare technologies.                         |  |
| 90 | Explain the applications of genetics in pharmacology.              | English: 10.5, 11.5, 12.5<br><br>Science: BIO.5  |
| 91 | Describe the impacts of biotechnology on preventive healthcare.    | English: 10.5, 11.5, 12.5<br><br>History and Social Science:<br>GOVT.15, VUS.1, WHII.1 |
| 92 | Define <i>forensic science</i> .                                   | English: 10.3, 10.5, 11.3, 11.5,<br>12.3, 12.5   |

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| 93  | Describe situations in which medical forensics can be used.  | English: 10.5, 11.5, 12.5                   |
| 94  | Describe situations in which forensic science can be used in criminal investigations.                        | English: 10.5, 11.5, 12.5                   |
| 95  | Describe situations in which biological forensic science can be used.  | English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5 |
| 96  | Demonstrate the basic instrumentation used in DNA analysis for forensic purposes.                            | English: 10.5, 11.5, 12.5<br>Science: BIO.1 |
| 97  | Define <i>bioengineering</i> .   | English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5 |
| 98  | Identify uses of nanobiotechnology.  |   |
| 99  | Identify examples of biowarfare.   | History and Social Science: WHII.1          |
| 100 | Design and produce a biomechanism.   | Science: BIO.1                              |
| 101 | Define <i>bioethics</i> .  |   |
| 102 | Assess impacts of biotechnology (including gene therapy, patenting of living tissue, cloning).               | History and Social Science: VUS.1, WHII.1   |
| 103 | Differentiate among ethical principles that reflect social, religious, economic, and political perspectives. | History and Social Science: WG.1            |
| 104 | Identify regulations that impact biotechnology.  | 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
- Animal Systems 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)
- Food Science and Dietetics (8239/36 weeks)
- Forensic Technology (8409/36 weeks)
- Introduction to Plant Systems (8007/36 weeks)
- Medical Laboratory Technology I (8377/36 weeks)
- Medical Laboratory Technology II (8378/36 weeks)
- Small Animal Care I (8081/18 weeks)
- Small Animal Care I (8083/36 weeks)
- Small Animal Care II (8084/36 weeks)
- Veterinary Science I (8088/36 weeks, 140 hours)
- Veterinary Science II (8089/36 weeks, 140 hours)

| Career Cluster: Agriculture, Food and Natural Resources |  |
|---|--|
| Pathway   | Occupations  |
| Animal Systems  | Animal Breeder, Husbandry<br>Animal Geneticist<br>Animal Scientist<br>Aquacultural Manager           |
| Environmental Service Systems                           | Environmental Compliance Inspector<br>Environmental Sampling and Analysis Technician<br>Toxicologist |

|   |   |
|---|---|
| <b>Food Products and Processing Systems</b>     | <b>Biochemist<br/>Food Scientist</b>                                |
| <b>Plant Systems</b>                            | <b>Botanist<br/>Forest Geneticist<br/>Plant Breeder/ Geneticist</b> |
| <b>Power, Structural, and Technical Systems</b> | <b>Agricultural Engineer</b>  |

| <b>Career Cluster: Health Science</b>         |  |
|---|--|
| <b>Pathway</b>                                | <b>Occupations</b>   |
| <b>Biotechnology Research and Development</b> | <b>Biochemist</b>  |
| <b>Diagnostics Services</b>                   | <b>Cardiovascular Technologist<br/>Computer Tomography (CT) Technologist<br/>Medical, Clinical Laboratory Technician<br/>Nuclear Medicine Technologist<br/>Radiologic Technologist, Radiographer</b> |
| <b>Health Informatics</b>                     | <b>Epidemiologist</b>  |
| <b>Support Services</b>                       | <b>Environmental Sampling and Analysis Technician<br/>Medical, Clinical Laboratory Technologist</b>  |

| <b>Career Cluster: Science, Technology, Engineering and Mathematics</b> |   |
|---|---|
| <b>Pathway</b>  | <b>Occupations</b>  |
| <b>Engineering and Technology</b>                                       | <b>Agricultural Engineer<br/>Biomedical Engineer<br/>Environmental Engineer</b> |
| <b>Science and Mathematics</b>  | <b>Biologist<br/>Environmental Scientist</b>                                    |