GEORGIA | PEACH STATE PATHWAYS

Career, Technical, & Agricultural Education

HEALTHCARE SCIENCE

PATHWAY: Biotechnology Research & Development

COURSE: Introduction to Biotechnology

UNIT 10: DNA Lab, Part II

INTRODUCTION

Annotation:

This unit will allow students to see the role of genomics and proteomics as a basis for biotechnology and the role that biotechnology products have in enhancing our quality of life. It will insure that each student gains explicit knowledge of the role of nucleic acid manipulation through genetic engineering in altering protein production and function.

Grade(s):

	9th
X	10th
X	11th
	12th

Time:

14 hours

Author:

Candice Little

Students with Disabilities:

For students with disabilities, the instructor should refer to the student's IEP to be sure that the accommodations specified are being provided. Instructors should also familiarize themselves with the provisions of Behavior Intervention Plans that may be part of a student's IEP. Frequent consultation with a student's special education instructor will be beneficial in providing appropriate differentiation.

FOCUS STANDARDS

GPS Focus Standards:

HS-IBT-2 **Students will understand the basis for biotechnology products and how such products affect the quality of life.**

d) Discuss the implications of the genomics and proteomics on biotechnology and current healthcare.

HS-IBT-6 **Students will demonstrate how manipulation of nucleic acids through genetic engineering (recombinant DNA and RNA technologies) alters the function of proteins and subsequent cellular processes.**

a) Describe the function of DNA, RNA, and protein in living cells and the Central Dogma.

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

- Isolate genomic and recombinant DNA from cells and solutions and analyze its purity and concentration.
- Explain and demonstrate the principles involved in DNA analysis via agarose gel electrophoresis.
- Describe previous and current DNA sequencing technologies.

c) Explain the role of enzymes (*e.g.,* restriction enzymes, DNA polymerases, and nucleases) in the production and manipulation of DNA molecules.

d) Determine and analyze the effect of qualitative and quantitative changes of specific proteins on cell function.

GPS Academic Standards:

SB2. **Students will analyze how biological traits are passed on to successive generations.**

ELA10RC2 **The student participates in discussions related to curricular learning in all subject areas. The student**

c) Relates messages and themes from one subject area to those in another area.

SB1. **Students will analyze the nature of the relationships between structures and functions in living cells.**

b) Explain how enzymes function as catalysts.

c) Identify the function of the four major macromolecules (i.e., carbohydrates, proteins, lipids, nucleic acids).

d) Explain the impact of water on life processes (i.e., osmosis, diffusion).

SB2. **Students will analyze how biological traits are passed on to successive generations.**

a) Distinguish between DNA and RNA.

b) Explain the role of DNA in storing and transmitting cellular information.

c.) Using Mendel's laws, explain the role of meiosis in reproductive variability.

d) Describe the relationships between changes in DNA and potential appearance of new traits including

- Alterations during replication.
  - Insertions

- Deletions
- Substitutions
- Mutagenic factors that can alter DNA.
- High energy radiation (x-rays and ultraviolet)
- Chemical

f) Examine the use of DNA technology in forensics, medicine, and agriculture.

UNDERSTANDINGS & GOALS

Enduring Understandings:

Genomics and proteomics play a substantial role in the development of biotechnology and the healthcare industry. Manipulation of nucleic acids through recombinant technologies alters the function of proteins and subsequent cellular processes. The sequence of nucleotides in DNA codes for a specific sequence of amino acids in a protein. The structure of DNA influences its ability to be analyzed and manipulated. Agarose gel electrophoresis is a technique used to analyze DNA. The amount and quality of protein have an important role in the nutrient's function.

Essential Questions:

- How are genomics and proteomics involved in the development of biotechnology and in the healthcare industry?
- How does the manipulation of nucleic acids through genetic engineering alter the function of proteins and subsequent cellular processes?
- How does the sequence of nucleotides in DNA code for a specific sequence of amino acids in a protein?
- How does the specific sequence of amino acids in a protein determine the function of the protein?
- How does the structure of DNA influence the possibility for it to be analyzed and manipulated?
- How is DNA analyzed via agarose gel electrophoresis?
- How does the concentration and quality of protein affect its function?

Knowledge from this Unit:

Students will be able to:

- List benefits and implications of knowing the DNA sequences of humans and other organisms.
- Explain how DNA is sequenced using several different methods
- List the uses of synthesized oligonucleotides and the attributes of good primers
- Describe the steps of PCR and the components and optimization of the process
- Explain the function of the thermocyler
- Describe applications of PCR technology
- Identify tools and applications of genomics and proteomics

Skills from this Unit:

Students will be able to:

- Sequence DNA and identify specific genes
- Perform a polymerase chain reaction
- Experiment with protein crystallography and mass spectrometry
- Perform an ELISA test
- Perform Southern and Western blots

ASSESSMENTS

Assessment Method Type:

_____ Pre-test
_____ Objective assessment – multiple-choice, true- false, etc.
__ Quizzes/Tests
__ Unit test
_____ Group project
_____ Individual project
_____ Self-assessment – May include practice quizzes, games, simulations, checklists, etc.
__ Self-check rubrics
__ Self-check during writing/planning process
__ Journal reflections on concepts, personal experiences and impact on one's life
__ Reflect on evaluations of work from teachers, business partners, and competition judges
__ Academic prompts
__ Practice quizzes/tests
_____ Subjective assessment/Informal observations
__ Essay tests
__ Observe students working with partners
__ Observe students role playing
_____ Peer-assessment
__ Peer editing & commentary of products/projects/presentations using rubrics
__ Peer editing and/or critiquing
_____ Dialogue and Discussion
__ Student/teacher conferences
__ Partner and small group discussions
__ Whole group discussions
__ Interaction with/feedback from community members/speakers and business partners
_____ Constructed Responses
__ Chart good reading/writing/listening/speaking habits
__ Application of skills to real-life situations/scenarios
_____ Post-test

LESSON PLANS

• LESSON 1: INTRODUCTION TO GENOMICS AND PROTEOMICS

1. Identify the standards. Standards should be posted in the classroom.

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  - Substitutions
  - Mutagenic factors that can alter DNA.
  - High energy radiation (x-rays and ultraviolet)
  - Chemical

f) Examine the use of DNA technology in forensics, medicine, and agriculture.

2. Review Essential Question(s). Post Essential Questions in the classroom.

- How are genomics and proteomics involved in the development of biotechnology and in the healthcare industry?
- How does the manipulation of nucleic acids through genetic engineering alter the function of proteins and subsequent cellular processes?
- How does the sequence of nucleotides in DNA code for a specific sequence of amino acids in a protein?
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- How is DNA analyzed via agarose gel electrophoresis?
- How does the concentration and quality of protein affect its function?

3. Identify and review the unit vocabulary. Terms may be posted on word wall.

BLAST – Central Dogma	Genomics	Northern Blot	RNA Interferance
Crystallography	Human Genome Project	Nuclear Magnetic Resonance	Salting Out
Cycle Sequencing	Introns	Pharmacogenetics	Short Interfering RNA
Dideoxynucleotides	Mass Spectrometry	Protein Arrays	Shotgun Cloning
Dideoxynucleotide Sequencing	MicroRNA	Protein (X-Ray) Crystallography	Transeritions & Translation
Exons	Nanotechnology	Proteome	Western Blot
Gel Electrophoresis	Neuro Array	Proteomics	X-Ray Diffraction Pattern

4. The Human Genome Project
    - Access **http://www.ornl.gov/sci/techresources/Human_Genome/graphics/slides/talks.shtml** and show students the **Genomics and Its Impact on Science and Society** PowerPoint presentation.
    - Lead a brief discussion about the use of genomics.
        - Ask students, "What do you think the purpose of genomics is?"
        - What are some genetic disorders found in humans?
        - How can genomics help find a cure for these disorders?
        - How are proteomics different from genomics?
        - How can proteomics and genomics help us to understand human diseases and physiology?

• LESSON 2: THE CENTRAL DOGMA

1. Review Essential Questions. Post Essential Questions in the classroom.

    - How does the manipulation of nucleic acids through genetic engineering (recombinant DNA and RNA technologies) alter the function of proteins and subsequent cellular processes?
    - How does the sequence of nucleotides in DNA code for a specific sequence of amino acids in a protein?
    - How does the specific sequence of amino acids in a protein determine the function of the protein?

2. DNA, RNA, and Proteins
    - Show students **The Central Dogma** PowerPoint presentation.
        - See attached supplementary files
    - Give students a DNA sequence and ask them to determine the mRNA sequence, tRNA sequence, and amino acid sequence which would result from it.
    - Have students alter their sequence just enough so that it results in a "mutation."
    - Lead a class discussion about genetic mutations and why they are important.

• LESSON 3: DNA EXTRACTION AND ANALYSIS

1. Review Essential Questions. Post Essential Questions in the classroom.

    - How does the structure of DNA influence the possibility for it to be analyzed and manipulated?
    - How is DNA analyzed via agarose gel electrophoresis?

2. DNA Extraction Lab
    - Split the class into small groups and give students a copy of the **DNA Extraction Lab**.
        - See attached supplementary files
    - Have students record their procedure and observations in their laboratory notebooks.

- After the experiment is complete, have students compare the difference between banana and strawberry DNA.

3. Gel Electrophoresis Lab
   - Give the lab groups a copy of the **Gel Electrophoresis Lab** and associated materials.
     - See attached supplementary files
   - Have students record t heir procedure and observations in their laboratory notebooks.

• LESSON 4: PROTEINS

1. Review Essential Questions. Post Essential Questions in the classroom.
   - How does the concentration and quality of protein affect its function?

2. Optimal Conditions
   - Explain to students there are certain optimal conditions for protein function, including temperature, pH, and concentration.
   - The three-dimensional structure of protein is a major contributor to its ability to function.
   - If the temperature or pH is too far off balance, the protein could denature and no longer work properly.

3. Potential Energy
   - Tell students the higher the concentration of reactants in a chemical reaction, the less activation energy is required to ensure the reactants come together.
   - Discuss the role of water in chemical reactions.

• NOTES & REFLECTION:

CULMINATING PERFORMANCE TASK

Culminating Unit Performance Task Title:

The effect of qualitative and quantitative changes on protein function

Culminating Unit Performance Task Description/Directions/Differentiated Instruction:

Students will research the topic in the computer lab at school and at home after choosing a specific protein that has a substantial role in the human body. Students will present the information they have found using a PowerPoint presentation or a poster presentation that includes each item on the presentation rubric.

UNIT RESOURCES

Web Resources:

http://www.ornl.gov/sci/techresources/Human_Genome/graphics/slides/talks.shtml

21st Century Technology Used:

	Slide Show Software		Graphing Software		Audio File(s)
x	Interactive Whiteboard		Calculator	x	Graphic Organizer
	Student Response System		Desktop Publishing		Image File(s)
	Web Design Software		Blog		Video
	Animation Software		Wiki		Electronic Game or Puzzle Maker
x	Email	x	Website		