GEORGIA | PEACH STATE PATHWAYS

Career, Technical, & Agricultural Education

HEALTHCARE SCIENCE

PATHWAY: Biotechnology Research & Development

COURSE: Introduction to Biotechnology

UNIT 7: Biotechnology DNA Lab 1

INTRODUCTION

Annotation:

Grade(s):

X	9th
X	10th
X	11th
X	12th

Time:

14 hours

Author:

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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.

c) Justify the steps in production and delivery of a product made using recombinant DNA technology.

GPS Academic Standards:

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

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

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.

UNDERSTANDINGS & GOALS

Enduring Understandings:

- Recombinant DNA technology is used to genetically alter cells.
- Genetically engineered organisms have modifications that make them capable of synthesizing new products potentially beneficial to mankind.
- Genes of interest can be isolated, purified, and transferred to other cells using several different techniques.
- Successful transformation of a cell results in the recipient cell acquiring the characteristics coded for on the newly added DNA.
- The DNA for each individual is unique and can be revealed by using restriction enzymes to separate it into fragments.
- Sufficient amounts of transfected cells are grown by using a scale-up process.
- The products of transformed cells are proteins which must be harvested and purified.
- The products of transformed cells must be packaged for use by the public using formulations such as: injectables, inhalers, patches, creams, and tablets, etc.
- Biotechnology companies must constantly monitor the concentration, purity, and activity of their products to ensure that it meets certain standards.
- Pharmaceutical protein products must be thoroughly described by filing an Investigational New Drug (IND) Application with the FDA and tested through clinical trials.
- Biotechnology companies should have carefully planned research and development goals for product sales and services, description of allocation of company resources and ways to improve financial returns

Essential Questions:

- Why are viruses often used as vectors to carry genes of interest into the mammalian host cells?

Knowledge from this Unit:

•Identify the fundamental steps in a genetic engineering procedure
•Give examples of genetically engineered products
•Describe the use of restriction enzymes in biotechnology research and recombinant protein production
•Describe restriction enzyme's mechanism of action.
•Discuss techniques used to probe DNA for specific genes of interest.
•Explain the steps of a bacterial transformation and various selection processes for identifying transfromants.
•Differentiate transformation, transfection, and transduction
•Explain the cell culture protocol for scale-up procedure
•Describe how plasmid preparations are performed and how their concentration and purity can be determined with a UV spectrophotometer

Skills from this Unit: Performance.

- Operation of a spectrophotometer
- Isolation and purification of DNA using probes and polymerase chain reaction (PCR)
- Cell transformation
- Making recombinant DNA
- Restriction fragment length polymorphisms (RFLP) analysis
- Scale-up process
- Use of assays
- Fermentation of cells
- Plasmid retrieval
- Hybridization
- Southern blotting
- Transduction-using viruses to transform cells

ASSESSMENTS

Assessment Method Type:

x Pre-test
____ Objective assessment - multiple-choice, true- false, etc.
__ Quizzes/Tests
__ Unit test
x Group project
____ Individual project
x Self-assessment - May include practice quizzes, games, simulations, checklists, etc.
_x_ Self-check rubrics
__ Self-check during writing/planning process
_x_ 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
_x_ Practice quizzes/tests
x Subjective assessment/Informal observations
_x_ 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
x Dialogue and Discussion
__ Student/teacher conferences
__ Partner and small group discussions
__ Whole group discussions
__ Interaction with/feedback from community members/speakers and business partners
x Constructed Responses
__ Chart good reading/writing/listening/speaking habits
_x_ Application of skills to real-life situations/scenarios
x Post-test

LESSON PLANS

- **LESSON 1: BENEFITS OF BIOTECHNOLOGY**

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

   HS-IBT-2 Students will understand the basis for biotechnology products and how such products affect the quality of life.
   c) Justify the steps in production and delivery of a product made using recombinant DNA technology.

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

   What are some benefits of biotechnology?

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

Lysozome	Probe	Autoradiogram
Southern blotting	cDNA	Reverse transcription
Thermocycler	Sticky ends	

4. Interest approach – Mental set

   Ask each student to identify one product produced through the use of biotechnology.

   Have the students write their response on a large piece of post it paper after the class agrees that it is truly a bioengineered product. This will be left up during this unit.

   Ask the students to identify what each of the products have in common.

   Ask the students to identify major categories the products can be grouped into.

5. Show students the PowerPoint titled **Benefits of Biotechnology**
6. Instruct each student to select a strip of paper with one of the 9 major categories of beneficial biotechnology products written on it. Each student will research some specific products that have been

produced in the category they selected. Students will answer the questions relevant to their product listed on the handout-**Beneficial Biotechnology Products**.

• LESSON 2: AN OVERVIEW OF GENETIC ENGINEERING

1. Review Essential Questions. Post Essential Questions in the classroom.
    - How are recombinant cells produced?
2. Describe the overall process that is involved in the production of recombinant cells while displaying a schematic diagram. The diagram can be found at www.google.com (images).
3. Discuss the objectives for making the poster and help students begin their project.
4. Distribute the handout-Make a poster illustrating the genetic engineering process. Ask students to find out what can go wrong at each step that can hinder the formation of recombinant cells.
5. Allow students to work on the poster for the remainder of the period and complete at home if necessary.

• LESSON 3: STRUCTURE AND FUNCTION OF DNA

1. Review Essential Questions. Post Essential Questions in the classroom.
    - What is the structure and function of DNA?
2. Display a colorful diagram of DNA which shows the major components of each of the nucleotides.
3. Describe characteristics of the DNA molecule, its role in the production of proteins, including transcription and translation.
4. Give each student a strip that has a model of one side of a DNA molecule. Instruct the students to identify the messenger RNA that would be complementary to the DNA and identify the amino acids that the transfer RNA will bring to the ribosome.
5. The teacher will assess the students based on the expected amino acid sequence.
6. Display a colorful diagram that represents 3 major types of mutations (deletions, insertions, inversions).
7. Instruct students to model each type of mutation in their original DNA to observe the effect that it will have on the protein structure.
8. Display a picture that shows sickle cell anemia. Tell them that a single nucleotide replacement in the DNA code for hemoglobin changes glutamic acid to valine and leads to the sickling shape in the cells under low oxygen conditions.
9. Challenge the students to form groups of 3-5 students and after a brief discussion predict ways that they believe gene therapy could be used to help people who have a genetic disorder.

• LESSON 4: ISOLATION OF GENETIC MATERIAL

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

    - How is genetic material isolated from the rest of the cell?

2. Give each student a handout to read silently explaining the steps to isolating DNA.

3. Form complementary groups of 3-4 students and review the major points in the lab activity.

4. Instruct the students to complete the lab activity while closely monitoring their progress and requiring that they each group moves at relatively the same pace.

5. Once the lab activity is completed, give the students time in class to answer the review questions. Each group will be responsible for turning in one set of answered questions with the names of all group members listed on it.

6. The teacher will lead a discussion about the possible use of the extracted DNA.

7. The ticket out the door will be one question that they have about the lab activity.

• LESSON 5: PROBING DNA FOR GENES OF INTEREST

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

    - How do scientists locate genes that code for a particular protein?

2. The teacher will initiate a discussion with the students by asking the following question: How can a person find a specific piece of DNA among all the other DNA in a strand? Each student will be required to prepare an answer and the teacher will randomly call on a student by picking a name from a set of student's names. Students will be given bonus points for attempting an answer. The rest of the students will vote yes or no based on whether they believe the answer could be correct or not.

3. The teacher will discuss the use of probes-
    A. Genomic DNA is isolated from cell samples, then loaded and run on a gel
    B. DNA probe with radiolabel which is the complement of the gene of interest is spread over the gel
    C. Probes bounce around until they find their complement
    D. They bind and emit radiation that can be seen on x-ray film or form a color reaction.
    E. The bound DNA can be removed for further processing.
    F. Polymerase chain reactions are carried out to amplify the number of the genes of interest

4. Make up an activity to demonstrate the law of attraction-How a probe can be used to locate something in a large group of other things. (Ex. Give the students a collection of balls, some made of metal, some made of glass. Direct the students to wave a magnet over the balls and observe which ones are attracted to the magnet. Discuss the properties in the balls and the magnet that make them attracted to each other. Extend that to the antigen antibody reaction used to probe for specific compounds in biotechnology.)

• LESSON 6 DNA Scissors

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

    • Under what circumstances is it useful to change a cell's DNA?

2. The teacher will display statistics about the incidence of diabetes in America, the cost of insulin prior to bioengineered insulin and after.

3. The teacher will lead a discussion about the benefits of bioengineered insulin.
    -Do you think more people died from diabetes before or after bioengineered insulin?
    -Do you think the availability of insulin makes people less concerned about their health?

4. The teacher will ask the students how the method of viral infection may have lead to bioengineering. After a brief discussion, the teacher will show the students a PowerPoint presentation to demonstrate how new DNA is inserted into an existing plasmid to make recombinant DNA transforming the cell into a protein making factory.

5. The students will be given an activity to complete by cutting paper strands that represent DNA being cut by EcoRI and applying the RFLP analysis to identify DNA from a known individual.

6. Students will compare results and identify which groups performed the activity correctly.

• LESSON 7: TYPICAL TRANSFORMATION

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

    • What are the steps involved in a typical transformation?

2. Student groups will be given a set of pictures and descriptions that are involved in the transformation process.

3. The teacher will instruct them to read a handout describing the process and organize the pictures in the correct sequence.

4. The teacher will circulate through out the room to determine who gets the sequence correct first, earning bonus points on the next test.

5. Students will watch a short video clip about the person who donated the immortal HeLa cells and discuss why they think her cells were useful to science and why it is important to use common cells when conducting cell research.

6. Ticket out the door-I still have a question about…..

• ATTACHMENTS FOR LESSON PLANS

    • **Benefits of Biotechnology PowerPoint**

- **Key Terms**

CULMINATING PERFORMANCE TASK

Culminating Unit Performance Task Description/Directions/Differentiated Instruction:

The business plan describing the formation of a biotechnology company will include a description of the recombinant protein being produced, the cell of origin, the vector used, the isolation method, technique for making the recombinant DNA, its insertion into the vector, and measuring the transformation efficiency. The scale-up process, preparation procedure to recover plasmids for reuse and testing for the presence of DNA in the samples of cells will be described as well. The next portion of the business plan will include a description of the protein harvesting and purification method including quality control techniques. The final portion of the business plan will outline the filing of the product with the FDA, marketing, sales, patent protection, and the search for additional product applications to help expand the company.

Attachments for Culminating Performance Task:

- FDA guidelines for biotechnology production
- Business plan from www.sba.gov website

UNIT RESOURCES

Materials & Equipment:

Petri dishes
Nutrient agar
Antibodies
Restriction enzymes
DNA probes with radiolabels or fluorescent labels
Ethanol
Glass rod
Marketed products of bioengineering
Vectors
PCR equipment
Autoradiogram equipment
Microcentrifuge
Enzymes (lysozyme, cellulose and pectinase to dissolve plant cell walls,
Gel electrophoresis
Autoradiogram
cDNA
Reverse transcriptase and polymerase
Primers
thermocyclers

21st Century Technology Used:

	Slide Show Software		Graphing Software		Audio File(s)
	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
	Email	X	Website		