GEORGIA | PEACH STATE PATHWAYS

Career, Technical, & Agricultural Education

HEALTHCARE SCIENCE

PATHWAY: Biotechnology Research & Development

COURSE: Introduction to Biotechnology

UNIT 9: Bacterial Transformation

INTRODUCTION

Annotation:

This unit involves lessons that will teach students the important skills and activities that are required to perform a successful transformation of cells by causing it to incorporate and express foreign DNA.

Grade(s):

	9th
X	10th
X	11th
	12th

Time:

10 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-5 **Students will compare and contrast common organisms used in biotechnology and relate the manipulation of living organisms to product and procedure development.**

a) Distinguish between prokaryotic cells, eukaryotic cells, and non-living entities such as viruses.

b) Describe the characteristics and life cycles of model organisms used in biotechnology, including bacteria (*e.g.,* E. *coli*), fungi (*e.g.,* yeasts and *Aspergillus*), and animals (*e.g.,* C. *elegans*, fruit flies, and rodents).

c) Monitor how environmental factors affect the growth of cells and model organisms in the laboratory.

d) Apply the basic concepts of cell growth to manipulate cultures under aseptic conditions in the laboratory.

e) Perform transformations, including competency, selection, antibiotic resistance, and analysis of transformation efficiency.

GPS Academic Standards:

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

a) Explain the role of cell organelles for both prokaryotic and eukaryotic cells, including the cell membrane, in maintaining homeostasis and cell reproduction.

SB2. **Students will derive the relationship between single-celled and multi-celled organisms and the increasing complexity of systems.**

d) Compare and contrast viruses with living organisms.

SB5. **Students will evaluate the role of natural selection in the development of the theory of evolution.**

e) Recognize the role of evolution to biological resistance (pesticide and antibiotic resistance).

SZ4. **Students will assess how animals interact with their environment including key adaptations found within animal taxa.**

c) Explain various life cycles found among animals (e.g., polyp and medusa in cnidarians; multiple hosts and stages in the platyhelminthe life cycle; arthropod metamorphosis; egg, tadpole, adult stages in the amphibian life cycle).

UNDERSTANDINGS & GOALS

Enduring Understandings:

Specific types of cells can be used to take up and express foreign DNA better than others. Transformation is the insertion and expression of foreign DNA into a cell. If the transformation is of a mammalian cell, it is called a transfection. Transformation s are usually done using recombinant plasmids or recombinant viral DNA. To make a recombinant plasmid, one or more restriction enzymes are needed to splice the donor and vector (plasmid) DNA molecules. Recombinant enzymes that produce matching sticky ends allow for the matching of pieces from different DNA sources. To seal the sticky ends, DBA ligase is needed. There are hundreds of

different known restriction enzymes. Each recognizes a specific sequence and will make a cut in the double-stranded DNA at or near the recognition sequence. Knowing the recognition sequence of a restriction enzyme helps a technician plan how to cut DNA molecules. Recognition-site information also helps to recognize plasmids and determine sites of interest.

Essential Questions:

- What are the similarities and differences between prokaryotes, eukaryotes, and viruses?
- What are key characteristics that are present in the life cycles of organisms which are used in biotechnology including bacteria, fungi and animals?
- How do environmental factors affect the growth of cells and model organisms in the laboratory?
- What are some of the basic concepts of cell growth that can be used to manipulate cultures under aseptic conditions in the laboratory?
- What are the procedures that are involved in a successful transformation to include competency, selection, antibiotic resistance, and analysis of transformation efficiency?

Knowledge from this Unit:

Students will be able to:

- Identify various types of cells based on their structure and function
- Identify the virus as a nonliving structure that has a vital influence on the cell
- List distinguishing characteristics for prokaryotic and eukaryotic cells
- List environmental factors that affect the growth of cells in the laboratory

Skills from this Unit:

Students will be able to:

- Use aseptic techniques in a lab
- Select cultures
- Grow cells in a lab
- Grow bacteria in a culture
- Manipulate cultures under aseptic conditions

ASSESSMENTS

Assessment Method Type

____ 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.
__ 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
x 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

x Dialogue and Discussion
__ Student/teacher conferences
__ Partner and small group discussions
_x_ 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

__ Post-test

LESSON PLANS

• LESSON 1: INTRODUCTION TO RECOMBINANT BIOTECHNOLOGY

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

HS-IBT-5 **Students will compare and contrast common organisms used in biotechnology and relate the manipulation of living organisms to product and procedure development.**

a) Distinguish between prokaryotic cells, eukaryotic cells, and non-living entities such as viruses.
b) Describe the characteristics and life cycles of model organisms used in biotechnology, including bacteria (*e.g.,* E. *coli*), fungi (*e.g.,* yeasts and *Aspergillus*), and animals (*e.g.,* C. *elegans*, fruit flies, and rodents).
c) Monitor how environmental factors affect the growth of cells and model organisms in the laboratory.
d) Apply the basic concepts of cell growth to manipulate cultures under aseptic conditions in the laboratory.
e) Perform transformations, including competency, selection, antibiotic resistance, and analysis of transformation efficiency.

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

a) Explain the role of cell organelles for both prokaryotic and eukaryotic cells, including the cell membrane, in maintaining homeostasis and cell reproduction.

SB2. **Students will derive the relationship between single-celled and multi-celled organisms and the increasing complexity of systems.**

d) Compare and contrast viruses with living organisms.

SB5. **Students will evaluate the role of natural selection in the development of the theory of evolution.**

e) Recognize the role of evolution to biological resistance (pesticide and antibiotic resistance).

SZ4. **Students will assess how animals interact with their environment including key adaptations found within animal taxa.**

c) Explain various life cycles found among animals (e.g., polyp and medusa in cnidarians; multiple hosts and stages in the platyhelminthe life cycle; arthropod metamorphosis; egg, tadpole, adult stages in the amphibian life cycle).

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

    - What are the similarities and differences between prokaryotes, eukaryotes, and viruses?
    - What are key characteristics that are present in the life cycles of organisms which are used in biotechnology including bacteria, fungi and animals?
    - How do environmental factors affect the growth of cells and model organisms in the laboratory?
    - What are some of the basic concepts of cell growth that can be used to manipulate cultures under aseptic conditions in the laboratory?
    - What are the procedures that are involved in a successful transformation to include competency, selection, antibiotic resistance, and analysis of transformation efficiency?

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

Amphibian Life Cycle	Cell	Homeostasis	Petri Dish	Scale Up
Animal	Clone	Incubation	Plant	Selection Media
Annual Tax	Cnidarians	Life Cycle	Platyhelminthes	Stereo Microscope
Antibiotic Resistance	Culture	Light Microscope	Polyp	Sterile
Anthropod Metamorphosis	Eukaryote	Media Competency	Prokaryote	Transformation
Bacteria	Fungi	Medusa	Recovery Period	Transformation Efficiency
Beta-Galactosidase Gene	Green Fluorescent Protein	Organelles	Recumbent	Virus

4. Interest approach – Mental set
    - Ask students, “How do you think cell transformation can better our quality of life?”
    - Show the students a brief video that shows how biotechnology used cellular transformation is used to increase our quality of life.

5. Cell Biology Review
    - Ask for a volunteer to distinguish between the structure and function of prokaryotes, eukaryotes and viruses by describing each one.
    - Have students complete the **Who’s Who in the World of Cell Biology** worksheet.
        - See attached supplementary files

• LESSON 2: ORGANISMS USED IN BIOTECHNOLOGY

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

    - What are key characteristics that are present in the life cycles of organisms which are used in biotechnology including bacteria, fungi and animals?
    - How do environmental factors affect the growth of cells and model organisms in the laboratory?

2. Research Organisms
    - Lead a brief discussion about the use of animals in biotechnology.
        - Ask students, “What organisms are used in biotechnology research?”
        - Do you know of any discoveries which occurred because of animal-based research?
        - What ethical considerations must take place when deciding whether to use animals?
    - Split the class into five groups and assign each one of the following organisms to research:
        - E. coli
        - Yeast
        - Aspergillus
        - C. elegans

    - Fruit flies
    - Mice
- Instruct each group to research their assigned organism and create a visual aid and presentation to answer the following questions:
    - What is the life cycle of your organism?
    - How has the organism been used in biotechnology?
    - What, if any, important discoveries resulted from the use of this organism?
    - How is the organism grown in a lab setting?
- Allow students time in class to work on and present their projects.

• LESSON 3: CELL CULTURE

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

    - What are some of the basic concepts of cell growth that can be used to manipulate cultures under aseptic conditions in the laboratory?

2. How Cells Grow
    - Break the class into small groups and ask each group to list the steps it would take to grow cells in the laboratory.
    - Have students list on a separate sheet of paper the following parameters cell cultures require:
        - Optimal temperature and pH
        - In what media the cells should be grown
        - Nutrients the cells require
        - Length of cell growth

3. Where are Microorganisms?
    - Give each group a Petri dish, swab, permanent marker, colored pencils, and a copy of the **Microorganism Search** worksheet.
        - See attached supplementary files
    - After students have collected samples in their Petri dishes, allow students to answer the first set of questions on their worksheet and place the dishes in a warm incubating area for 24 hours.

4. Aseptic Technique
    - Break the class into two large groups.
    - Instruct the groups to go to the restroom and wash their hands thoroughly, using soap and warm water, and ask them not to touch anything in order to remain sterile.
    - Have students in one group rub small amounts of petroleum jelly on their hands.
    - Shine a black light over the hands of both groups – the petroleum jelly should glow blue, and students whose hands are clean should not glow much at all.
    - Ask students with petroleum jelly to shake the hand of one student in the opposite group.
    - Shine the black light over the "clean" hands again. This time this group's hands should glow blue also.
    - Explain to students this experiment demonstrates how easily it is to spread germs, and not even know it.
    - Lead a discussion about aseptic technique.
        - Ask students, "What does it mean to be sterile?"
        - Why is it important to be sterile in a laboratory setting?
        - What are some things you can do in a lab to remain sterile during an experiment?
        - What do you think non-sterile conditions can do to the results of an experiment?

5. Where are Microorganisms? Part Two
    - Remove the Petri dishes from the incubator and pass them back out.

- Allow students to observe their Petri dishes under a microscope and record their observations.
- Instruct students to answer the rest of the questions about their Petri dishes on their **Microorganism Search** handout.

• LESSON 3: CELL TRANSFORMATION

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

    - What are the procedures that are involved in a successful transformation to include competency, selection, antibiotic resistance, and analysis of transformation efficiency?

2. Lead a discussion about cellular transformation.
    - Ask students, "What is cellular transformation?"
    - What are some uses for cell transformation in forensics, medicine, and agriculture?
    - When a cell is transformed, what is really happening?
    - What are some proteins cells can be manipulated to produce?
    - What are some criteria that go into the selection of a cell to be used in transformation studies?

3. Cell Transformation Overview
    - Access and show the class the Bio-Rad PowerPoint presentation on bacterial transformation at **http://www.bio-rad.com/LifeScience/jobs/2008/08-0147/docs/pGLO_GFP_031208.ppt**.

4. Cell Transformation Lab
    - **Note:** This lab requires the use of the Bio-Rad pGLO kit, available online.
    - Have students complete the cell transformation lab and record all observations in a laboratory notebook.

• ATTACHMENTS FOR LESSON PLANS

Who's Who in the World of Cell Biology?
Microorganism Search

• NOTES & REFLECTION:

This section allows students to see that although biotechnology is using and developing cutting-edge techniques and products, the procedures are simple enough that they can master them in a semester and go on to secure an entry level position with a biotechnology company making well above minimum wage.

CULMINATING PERFORMANCE TASK

Culminating Unit Performance Task Title:

UNIT RESOURCES

Web Resources:

http://www.bio-rad.com/LifeScience/jobs/2008/08-0147/docs/pGLO_GFP_031208.ppt

Materials & Equipment:

- Host cells
- Broth culture
- Calcium chloride or magnesium chloride
- DNA plasmids
- Ice cold water
- Hot water bath (temperature depends on host cell requirements)
- Petri dishes containing growth medium
- Selection genes
- Petroleum jelly
- Black light

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	x	Video
x	Animation Software		Wiki		Electronic Game or Puzzle Maker
	Email	x	Website		