GEORGIA | PEACH STATE PATHWAYS

Career, Technical, & Agricultural Education

HEALTHCARE SCIENCE

PATHWAY: Biotechnology Research & Development

COURSE: Applications of Biotechnology

UNIT 8: Proteins

# INTRODUCTION

**Annotation:** This unit introduces students to the methods of protein extraction, chromatography, and antibody purification. Students will perform methods of protein measurement, quantification, and characterization including Western blot, polyacrylamide gel electrophoresis, ELISA tests, and UV/VIS spectrophotometer.

**Grade(s):**

| | |
|---|---|
| | 9th |
| | 10th |
| X | 11th |
| X | 12th |

**Time:** Twenty 50-minute class periods

**Author:** Mandy Latimer

**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-ABT-7** **Students will demonstrate proficiency in advanced biotechnology techniques.**

i) Perform methods of protein extraction such as salt precipitation and dialysis, chromatography, and antibody purification.

j) Describe and perform methods of protein measurement, quantification, and characterization such as: Western blot, polyacrylamide gel electrophoresis, ELISA, and UV/VIS spectrophotometry.

## GPS Academic Standards:

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

**SB3** Students will derive the relationship between single-celled and multi-celled organisms and the increasing complexity of systems.

**SB4** Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.

**SCSh3** Students will identify and investigate problems scientifically.

**SCSh4** Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

**SCSh5** Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

**SCSh6** Students will communicate scientific investigations and information clearly.

**SC7** Students will characterize the properties that describe solutions and the nature of acids and bases.

**SCSh8** Students will understand important features of the process of scientific inquiry.

**SPS10** Students will investigate the properties of electricity and magnetism.

**MM1A1** Students will explore and interpret the characteristics of functions, using graphs, tables, and simple algebraic techniques.

**MM1D3** Students will relate samples to a population.

**MM1P1** Students will solve problems (using appropriate technology).

**MM1P4** Students will make connections among mathematical ideas and to other disciplines.

**MM1P5** Students will represent mathematics in multiple ways.

**MM2D2** Students will determine an algebraic model to quantify the association between two quantitative variables.

# UNDERSTANDINGS & GOALS

## Enduring Understandings:

Most biotechnology companies manufacture novel proteins or use them in research and development. The importance of biotechnology in the production of life-saving drugs is well-illustrated by the story behind insulin. Insulin was the first recombinant DNA drug, and it improved and saved the lives of millions of people who had to depend on the insulin extracted from the pancreases of pigs and cattle.

## Essential Questions:

- What does the molecular structure of protein look like?
- How are biotechnologically-produced enzymes used in the industry today?
- Why is *E. coli* used in the production of proteins?

- How are proteins measured?
- How are proteins used to clean up pollution?
- What is BST and where is it produced?
- How are proteins purified from complex mixtures such as blood?
- What types of proteins are found in cheese

**Knowledge from this Unit:**

Students will be able to:

- Describe the molecular structure of proteins
- Explain how mixtures of proteins are separated from one another
- Explain how to test samples for the presence of proteins
- List how enzymes are important in at least three processes
- List and describe three proteins used in medicine

**Skills from this Unit:**

Students will be able to:

- Run an ELISA test
- Use a spectrophotometer to run a Bradford assay
- Demonstrate how to test for enzyme activity
- Run a SDS gel electrophoresis
- Make cheese

## ASSESSMENTS

**Assessment Method Type:**

____ Pre-test

X Objective assessment - multiple-choice, true- false, etc.
- __X Quizzes/Tests
- __ Unit test

X 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

X Subjective assessment/Informal observations
- __ Essay tests
- _X_ 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
____ Constructed Responses
__ Chart good reading/writing/listening/speaking habits
__ Application of skills to real-life situations/scenarios
____ Post-test

**Assessment Attachments and / or Directions:**

## LESSON PLANS

- **LESSON 1:**

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

| | |
|---|---|
| **HS-ABT-7** | **Students will demonstrate proficiency in advanced biotechnology techniques.**<br>i) Perform methods of protein extraction such as salt precipitation and dialysis, chromatography, and antibody purification.<br>j) Describe and perform methods of protein measurement, quantification, and characterization such as: Western blot, polyacrylamide gel electrophoresis, ELISA, and UV/VIS spectrophotometry. |
| **SB1** | Students will analyze the nature of the relationships between structures and functions in living cells. |
| **SB3** | Students will derive the relationship between single-celled and multi-celled organisms and the increasing complexity of systems. |
| **SB4** | Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems. |
| **SCSh3** | Students will identify and investigate problems scientifically. |
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| **MM1P4** | Students will make connections among mathematical ideas and to other disciplines. |
| **MM1P5** | Students will represent mathematics in multiple ways. |
| **MM2D2** | Students will determine an algebraic model to quantify the association between two quantitative variables. |

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

- What does the molecular structure of protein look like?

- How are biotechnologically-produced enzymes used in the industry today?
- Why is *E. coli* used in the production of proteins?
- How are proteins used to clean up pollution?
- What is BST and where is it produced?
- How are proteins purified from complex mixtures such as blood?
- What proteins are found in cheese?
- How are proteins measured?

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

| | | |
|---|---|---|
| Amylases | Centrifugation | Insulin |
| Antibody | Chromatography | Lipases |
| Antigen | Diafiltration | Precipitation |
| Bioreactors | Dialysis | Proteases |
| Bradford assay | Gel Electrophoresis | SDS Page |
| BST | Hormones | Spectrophotometer |
| Cellulase | Ion Exchange Chromatography | Western Blot |

4. Interest approach – Mental set
   - Explain to students that proteins are large molecules required for structure, function, and regulation of living cells.
   - Ask students, "Why do you think it is important for scientists to study proteins?"
   - What are some proteins found in products we use on a daily basis?
   - What types of information can be found out from studying proteins?

5. Protein Research
   - Break the class into groups, and have each group choose one of the following topics to research online. Make sure they write down information in their lab notebooks.
     - Enzymes in the laundry
     - Cheese making and Chymosin
     - Paper manufacturing
     - Pollution control
     - Mass-produced proteins
     - Medical uses of proteins
     - Purified proteins

6. Protein Structure
   - Give students a copy of the **Protein Structure** handout.
     - See attached supplementary files
   - Show students the filled-out copy and have them write the information about each of the structures on the handout.

## • LESSON 2: PROTEIN PURIFICATION AND PROCESSING

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

   - How are proteins purified from complex mixtures such as blood?
   - What types of proteins are found in cheese?

2. Methods of Purification

- Column Chromatography
    - Explain to students that in this method, protein samples can be run over a column filled with different types of gel matrices, which separates proteins by size.
    - pH is very important in this process.
- Dialysis
    - Explain to students that sometimes, protein samples need to be in a different buffer in order to be processed further.
    - Dialysis can help do this.
    - **Note:** You can obtain some dialysis tubing and run a sample dialysis for your classes using a protein solution and a beaker filled with water.

3. Purification of Hemoglobin
    - Lead a brief discussion about protein purification.
        - Ask students, "Why do scientists need to purify, or extract, proteins?"
        - What is hemoglobin?
        - What can we use hemoglobin for once it is extracted?
    - Have students review protocols for separating hemoglobin from blood.
    - Instruct students to choose one procedure and record it in their lab notebooks. Ask them to explain why they chose this procedure in a short paragraph.

4. Processed Proteins in Cheese
    - Ask students to list types of cheeses on the board, classified as "Hard Cheeses" and "Soft Cheeses."
    - Split students into small groups and have each group choose a type of cheese to make.
    - Using the **Cheese Making Notes** and procedures researched online, have students create an experiment to make their chosen cheese.
        - See attached supplementary files
        - Make sure the procedures are recorded in students' lab notebooks.
    - Instruct students to perform their experiments and create their cheese.
    - **Note:** Bring in some crackers and breads to let students sample each others' products at the end of the unit.

## • LESSON 3: PROTEIN MEASUREMENTS

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

    - How are proteins measured?

2. Methods of Protein Measurement
    - Read the following to your students and have them take notes in their lab notebooks.
    - ELISA Test (Enzyme-Linked Immuno Sorbent Assay)
        - This test detects the presence of an antibody or antigen in a sample.
        - ELISA has been used as a diagnostic tool in medicine and plant pathology, and a quality control check in different industries.
        - Antigen and antibody complexes are formed during an ELISA test, and some will fluoresce so the amount of antigen in the sample can be measured.
    - Polyacrylamide Gel Electrophoresis
        - Proteins can be separated by size by running samples in an SDS, a type of polyacrylamide gel, using electric current.
        - Because proteins, like DNA, are electrically charged, they will move down the gel with the current.

    - The gels are stained with coomassie blue so the proteins can be visualized.
- Western Blotting
    - This is used to separate proteins by blotting target proteins onto a special paper, and then exposing the paper to a labeled antibody.

3. Measurement Protocols
    - Instruct students to go online and review one protocol for each of the above methods.
    - Have them write the procedures in their lab notebooks.
    - Obtain the necessary materials, and have students practice each experiment.

4. Protein in Milk
    - Using a spectrophotometer and the Bradford assay, have students measure different amounts of protein in milk.
    - Instruct students to make a standard curve on Microsoft Excel to plot their data.
    - Have students compare their spectrophotometer graph to their Excel curve.
        - Students will be able to see how well the samples compare to one another.

5. Summary
    - Instruct students to write a one to two-page paper describing the different ways proteins can be measured.
    - They should include:
        - Description of each method and what it is used for
        - One way the method is used in modern biotechnology
        - The affects this procedure has had on science
        - Which procedure they liked best and why

## • ATTACHMENTS FOR LESSON PLANS

## • NOTES & REFLECTION:

**Protein Structure**
**Cheese Making Notes**
**Vocabulary Glossary**

# CULMINATING PERFORMANCE TASK

### Culminating Unit Performance Task Title:

Any of the laboratory experiment tasks in the unit, including the ELISA test, a Bradford assay, SDS gels, and Western blots can be used as a culminating unit performance task. Students can practice lab techniques, such as pouring agar gels, and then be asked to perform them for a grade.

### Culminating Unit Performance Task Description/Directions/Differentiated Instruction:

Students will conduct a controlled experiment, either using a procedure they designed or one given to them, and analyze and report the data collected. All procedures, observations & results should be reported in the students' lab books.

**Attachments for Culminating Performance Task:**

## UNIT RESOURCES

**Web Resources:**

**www.protocol-online.org**
**biology.clc.uc.edu/fankhauser/cheese/cheese_course/cheese_course.htm**
**www.cheesemaking.com**

**Materials & Equipment:**

- Suggested Texts:
  - Biotechnology: Science for the New Millennium by Ellyn Daugherty
  - Introduction to Biotechnology by William J Thieman & Michael Palladino
- Suggested Lab Kits:
  - Bio-Rad kits

**21st Century Technology Used:**

| | | | | | |
|---|---|---|---|---|---|
| | Slide Show Software | x | Graphing Software | | Audio File(s) |
| | Interactive Whiteboard | x | Calculator | | 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 | | |