

Course Name : Project Lead the Way-Principles of Biomedical Sciences

Course Overview

Principles of Biomedical Science (PBS) is a full-year high school course in the PLTW Biomedical Science Program. This course serves to provide foundational knowledge and skills in fields such as biology, anatomy & physiology, genetics, microbiology, and epidemiology as well as engage students in how this content can be applied to real-world situations, cases, and problems.

Course Materials/Resources/Technology:

- Curriculum and content are located online through the PLTW Inkling website (annual subscription required)
- Lab Materials are located and ordered through the PLTW online store

UNIT 1: Medical Investigation

Duration of Unit: 41 Days

Description of Unit: In Unit 1 students engage in forensic science and medical examination investigations in order to: a.) explore biological and forensic science careers; b.) gain experience in experimental design and data analysis; c.) learn about biomolecules and their role in determining identity; d.) learn about human anatomy and physiology and causes of death; e.) practice synthesizing multiple forms of data to draw conclusions; and f.) work to develop professional communication skills.

Essential Questions and/or Enduring Understandings:

- What are different forms of evidence, how infallible are they, and how are they useful in resolving potential criminal cases?
- How can varying forms of evidence be evaluated for meaning?
- How does technology help bring resolution to forensic cases? Or how does technology advance the understandings in forensic science?
- How can the cause, mechanism, and manner of death be established?
- What information can be collected from an autopsy?
- How can information collected during an autopsy lead to an understanding of disease and/or cause of death?
- In what ways are the careful evaluation of evidence and accurate recording of data critical to establishing legitimate testimony?
- How can individual pieces of evidence, evaluated against the whole, be used to resolve questions?

- In what ways can scientific writings and presentations be utilized to present evidence and justify conclusions?
- To what extent can current understandings be reinforced through practice?

Academic Vocabulary:

- Forensic Scientist
- Decedent
- Biomedical Scientist
- Person of Interest
- Physiological Response
- Polygraph Tests
- Heart Rate
- Vital Signs
- Pulse
- Respiratory Rate
- Control
- Experiments
- Hypothesis
- Experimental Design
- Iterative
- Independent Variable
- Dependent Variable
- Trace evidence
- Locard's exchange principle
- Ridges (fingerprints)
- Minutiae (fingerprints)
- Forensic Science
- Digital footprint
- Plasma
- Erythrocytes
- Thrombocytes
- Leukocytes
- Hemoglobin
- Antigen
- Antibody
- Positive Control
- Negative Control

- Hypothesis
- ABO System
- Agglutination
- Independent variable
- Dependent variable
- Standard Curve
- Presumptive Testing
- Confirmatory Testing DNA Profile
- Gel Electrophoresis
- DNA Ladder
- Restriction Fragment Length Polymorphisms
- Deoxyribonucleic acid (DNA)
- Proteins
- Nucleotides
- Nitrogenous bases
- Adenine
- Thymine
- Guanine
- Cytosine
- Genetics
- Genes
- Genome
- Cells
- Organelles
- Eukaryotic cells
- Prokaryotic cells
- Chromosomes
- Histones
- DNA Profiling
- Polymerase chain reaction (PCR)
- Restriction endonucleases
- Recognition sites
- Restriction digestion
- Gel electrophoresis

Materials/Resources/Technology:

ESSENTIAL Standards	Learning Targets
<p>O9.1 Explain the role of DNA, RNA, and proteins in the inheritance of traits and the development of diseases or disorders.</p>	<ol style="list-style-type: none"> 1. Students can summarize the process of protein synthesis with the aid of a graphic organizer. 2. Students can accurately model the production of a protein from DNA to polypeptide. 3. Students can identify how mutations (substitution, insertion, and deletion) potentially alter the production of proteins.
<p>O9.4 Select and use appropriate tools, techniques, and/or technologies to analyze genetic information and diagnose disease.</p>	<ol style="list-style-type: none"> 1. I can define the purpose of gel electrophoresis. 2. I can explain and demonstrate techniques in molecular biology (DNA extraction, restriction digestion, gel electrophoresis) and interpret results. 3. I can, given a DNA fragment and restriction enzyme, “cut” in the correct loci, count the number of bases pairs in the fragment, and plot the fragments on a paper gel to interpret results.
<p>O8.1 Document patient information.</p>	<ol style="list-style-type: none"> 1. Requires guidance to correctly use medical terminology to transcribe and communicate information, data, and observations. 2. Uses medical terminology to transcribe and communicate information, data, and observations. 3. In all instances, accurately uses medical terminology to transcribe and communicate information, data, and observations.
<p>O8.2 Synthesize complex medical information to diagnose a disease, disorder, or injury or to determine</p>	<ol style="list-style-type: none"> 1. Selects and uses some, but not all, appropriate diagnostic tools and tests to evaluate a patient’s condition or selects inappropriate diagnostic tools. 2. Selects and uses appropriate diagnostic tools and tests to evaluate a patient’s condition. 3. Selects and uses appropriate diagnostic tools and tests, and can identify others, to evaluate a patient’s condition.
<p>O8.3 Respond to patient and/or community needs and propose treatment strategies for disease, disorder, injury, or the prevention thereof.</p>	
<p>O12.1 Explain the connection between structure and function in biology.</p>	<ol style="list-style-type: none"> 1. Describes generally the anatomy and physiology of key human body systems, as well as the organization and interaction of these systems. 2. Accurately describes the anatomy and physiology of key human body systems, as well as the organization and interaction of these systems. 3. Accurately describes and can illustrate the anatomy and physiology of key human body systems, as well as the organization and interaction of these systems, citing relevant examples.
<p>O12.2 Describe how the systems of the body work together to maintain</p>	

homeostasis.	
NICE TO KNOW Standards	Learning Targets
Common Formative and Summative Assessments	
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UNIT 2: Clinical Care
Duration of Unit: 43 Days
Description of Unit: Students assume the role of different medical professionals working through the schedule of patients in a family care clinic in order to: a.) explore medical careers; b.) practice professional communication; c.) gain experience collecting, recording, and interpreting physiological data; d.) learn how to perform routine medical tests and evaluate results; e.) learn about cutting edge technologies revolutionizing healthcare; f.) understand the interconnectedness between body systems; and g.) explore the various causations and inheritance of disease.
Essential Questions and/or Enduring Understandings: <ul style="list-style-type: none"> ● How can an individual's health status be assessed and evaluated? ● What factors make an individual more susceptible to disease? ● What are strategies for maintaining health? ● What are effective means of communicating with others in order to reach common goals? ● What qualities make for an effective medical professional? ● In what ways, and for what purpose, can patient confidentiality be maintained?

- How can changes in a genome lead to disease?
- Why is an understanding of heredity an important factor in human health?
- In what ways are genetic changes acquired?
- In what ways can altered biological processes lead to disease?
- How can the genetic health of an individual be evaluated?

ESSENTIAL Standards	Learning Targets
O11.1 Explain how the composition, structure, and activities of cells build functional systems in the human body.	
O9.1 Explain the role of DNA, RNA, and proteins in the inheritance of traits and the development of diseases or disorders.	<ol style="list-style-type: none"> 1. Students can summarize the process of protein synthesis with the aid of a graphic organizer. 2. Students can accurately model the production of a protein from DNA to polypeptide. 3. Students can identify how mutations (substitution, insertion, and deletion) potentially alter the production of proteins.
O9.2 Describe cell division and the process by which chromosomes replicate leading to genetic diversity.	<ol style="list-style-type: none"> 1. Define the structure, function, and number of chromosomes in human body cells v. sex cells. 2. Define and summarize the process of mitosis and meiosis. In addition, compare and contrast the two processes of cell division. Furthermore, define possible structural changes to chromosomes. 3. Complete a cytogenetic report given chromosomes of a patient.
O9.3 Analyze genetic information to predict patterns of inheritance	<ol style="list-style-type: none"> 1. Students can define key terms: heterozygous, homozygous, genotype, phenotype, dominant, recessive, pedigree, and Punnett square. 2. Students can calculate the probability of genetic traits being passed to offspring using a Punnett square. 3. Students can interpret a pedigree and analyze genetic information from a gel electrophoresis to create a pedigree.
O12.1 Explain the connection between structure and function in biology.	<ol style="list-style-type: none"> 1. Describes generally the anatomy and physiology of key human body systems, as well as the organization and interaction of these systems. 2. Accurately describes the anatomy and physiology of key human body systems, as well as the organization and interaction of these systems. 3. Accurately describes and can illustrate the anatomy and physiology of key human body systems, as well as the organization and interaction of these systems, citing relevant examples.
O12.2 Describe how the systems of the body work together to maintain homeostasis.	
NICE TO KNOW	Learning Targets

Standards	
Common Formative and Summative Assessments	
<ul style="list-style-type: none"> ● 	

Unit 3: Outbreaks and Emergencies
Duration of Unit: 42 Days
<p>Description of Unit: Working as public health officials and then as emergency responders, students are presented with a series of events they must address while exploring: a.) careers in public health, epidemiology, microbiology and emergency medicine; b.) professional communication and presentation; c.) data analysis; d.) processes by which critical medical decisions are made and acted upon; e.) processes by which patients are diagnosed with a contagious disease and by which a causative agent is identified.</p>
<p>Essential Questions and/or Enduring Understandings:</p> <ul style="list-style-type: none"> ● In what ways, and for what purpose, can microorganisms be characterized? ● What factors affect the growth and death of microorganisms? ● What are effective strategies for preventing and treating disease? ● How does an immune system identify and eradicate infection? ● How can pieces of evidence be evaluated to form conclusions and inform decisions? ● How can an individual's health status be assessed and evaluated? ● How is patient case information summarized and communicated efficiently?

- What professions respond in emergency situations, what are their roles, and how do they work together?
- What are several career paths in the field of emergency medicine?
- How do patient vitals and presumptive diagnoses inform the prioritization for treatment options in emergency medical situations?
- What make for effective emergency and disaster response protocols?
- How do medical professionals manage emergencies that involve multiple patients?
- To respond to emergency situations, what common medical resources and facilities need to be available?
- What are features of a user-friendly app?
- In what ways can technology enable a faster response and quicker resolution during medical emergencies?

ESSENTIAL Standards	Learning Targets
O11.1 Explain how the composition, structure, and activities of cells build functional systems in the human body.	
O10.1 Identify and describe pathogens that cause infectious disease.	
O10.2 Describe how the components of the human immune system fight disease and can be used in prevention and diagnosis.	
O8.1 Document patient information.	<ol style="list-style-type: none"> 1. Requires guidance to correctly use medical terminology to transcribe and communicate information, data, and observations. 2. Uses medical terminology to transcribe and communicate information, data, and observations. 3. In all instances, accurately uses medical terminology to transcribe and communicate information, data, and observations.
O8.2 Synthesize complex medical information to diagnose a disease, disorder, or injury or to determine	<ol style="list-style-type: none"> 1. Selects and uses some, but not all, appropriate diagnostic tools and tests to evaluate a patient's condition or selects inappropriate diagnostic tools. 2. Selects and uses appropriate diagnostic tools and tests to evaluate a patient's condition. 3. Selects and uses appropriate diagnostic tools and tests, and can identify others, to evaluate a patient's condition.
O8.3 Respond to patient and/or community needs and propose treatment strategies for disease, disorder, injury, or the prevention thereof.	

<p>O12.1 Explain the connection between structure and function in biology.</p>	<ol style="list-style-type: none"> 1. Describes generally the anatomy and physiology of key human body systems, as well as the organization and interaction of these systems. 2. Accurately describes the anatomy and physiology of key human body systems, as well as the organization and interaction of these systems. 3. Accurately describes and can illustrate the anatomy and physiology of key human body systems, as well as the organization and interaction of these systems, citing relevant examples.
<p>NICE TO KNOW Standards</p>	<p>Learning Targets</p>
<p>Common Formative and Summative Assessments</p>	
<ul style="list-style-type: none"> ● 	

<p>Unit 4: Innovation Inc.</p>
<p>Duration of Unit: 45 Days</p>
<p>Description of Unit: Welcome to PLTW Innovation, Inc. – an incubator for innovation where some of the best minds in science and engineering endeavor to solve some of the world’s most pressing biomedical challenges. Students tour Innovation, Inc. labs and engage in experiences designed to: a.) build their engineering and experimental design process skills, b.) challenge them to design solutions to current and emerging issues both on and off this world, c.) tangibly highlight that solutions to biomedical science problems rely on collaboration between professions, d.) build their computer science skills by using computer aided design (CAD) and geographic information system (GIS) to innovate the future of medicine, and e.) explore career fields on the forefront of medicine.</p>
<p>Essential Questions and/or Enduring Understandings:</p> <ul style="list-style-type: none"> ● How do the engineering and experimental design processes enable innovation?

- Who innovates, and why?
- What is the process for innovation and what personal characteristics are required for success?
- How do innovations impact and advance human health?
- How does technology function as a vehicle for innovation?
- In what ways do different types of scientists and engineers collaborate in the biomedical sciences field?
- What are potential untapped resources that could work to advance the field of biomedical sciences?

ESSENTIAL Standards	Learning Targets
NICE TO KNOW Standards	Learning Targets

Common Formative and Summative Assessments

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Principles of Biomedical Sciences Standards-Based Grades by Domain

Experimental Design	
<p><i>An experimental design process is a systematic approach to investigate and gain knowledge. Develop a testable hypothesis and design an experimental protocol that evaluates its validity. Distinguish between independent and dependent variables. Identify and explain the purpose and importance of experimental controls. Select and use equipment appropriately to conduct experiments. Identify possible sources of errors, then redesign and repeat the experiment when appropriate.</i></p>	
Assessed: Activity 1.1.4, Activity 1.2.2, Activity 2.2.6	Score
1. Students can develop a researchable question and testable hypothesis.	
2. Students can create an experimental protocol with correctly identified independent, dependent, and control variables.	
3. Students can redesign an experimental protocol, based on results and possible sources of error, to improve the outcome of the experiment.	

Data Analysis	
<p>Collect and analyze experimental data to draw conclusions. Perform necessary calculations to analyze experimental data. Display experimental data appropriately and accurately in digital or written form (graphs, tables, diagrams). Perform necessary calculations to analyze experimental data. Draw logical conclusions from experimental data. Communicate experimental findings with appropriate audiences both orally and in writing.</p>	
Assessed: Activity 1.1.6, Activity 1.2.6, Activity 2.1.4, Activity 2.2.4, Activity 3.1.3, Activity 3.1.4	Score
1. Students can collect data given a data table with identified independent and dependent variables.	
2. Students can independently and appropriately display data in written or digital form (graphs, charts, diagrams).	

3. Students can independently perform necessary calculations to analyze data and draw logical conclusions from the experimental data.	
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Career and Professionalism	
<i>Biomedical science solutions have global impacts in economic, environmental, and societal contexts. Describe the diverse set of careers in the biomedical sciences and the societal impacts of their work. Successful biomedical scientists typically exhibit specific personal and professional characteristics that lend themselves to the creative, collaborative, and solution-driven nature of the profession.</i>	
One assessed standard, completed, with evidence, at the end of each semester.	Score
<ul style="list-style-type: none"> ● Identify and describe the different careers of professionals who research, diagnose, and treat medical conditions. ● Describe the education requirements, salary ranges, professional licensure, skills, and/or responsibilities of biomedical science professionals. ● Describe the impact that biomedical science research and interventions have on society. 	

General Laboratory Practice	
<i>The practice of biomedical sciences requires the application of common tools, techniques, and technologies to solve problems.</i>	
Ongoing assessment.	Score
<ul style="list-style-type: none"> ○ Use and apply principles of measurement. ○ Develop and utilize a standard curve ○ Practice precise and accurate micropipetting. ○ Demonstrate proper use of a microscope to view biological samples ○ Demonstrate aseptic technique. ○ Practice culturing techniques. ○ Demonstrates an ability to accurately follow a lab protocol. 	

Clinical Medicine
Patient records and other pieces of medical evidence can be used to assess a person's health and identify disease.

Standard	Assessed	Score	Comment
O8.1 Document patient information.	Activity 1.2.6, Lesson 2.1, Activity 3.1.4		
O8.2 Synthesize complex medical information to diagnose a disease, disorder, or injury or to determine	Activity 1.2.6, Lesson 2.1, Activity 3.1.4		
O8.3 Respond to patient and/or community needs and propose treatment strategies for disease, disorder, injury, or the prevention thereof.	Activity 1.2.6, Activity 3.1.4		

Molecular Biology and Genetics			
Analyzing DNA offers insight into human identity and the causes of genetic diseases.			
Standard	Assessed	Score	Comment
O9.1 Explain the role of DNA, RNA, and proteins in the inheritance of traits and the development of diseases or disorders.	Activity 1.1.6, Activity 2.2.3		
O9.2 Describe cell division and the process by which chromosomes replicate leading to genetic diversity.	Activity 2.2.6		
O9.3 Analyze genetic information to predict patterns of inheritance	Activity 2.2.6		
O9.4 Select and use appropriate tools, techniques, and/or technologies to analyze genetic information and diagnose disease.	Activity 1.1.6, Lesson 2.1		

Microbiology

Biomedical scientists study and manipulate microorganisms to understand their properties (i.e., growth and behavior) and their role in infectious disease.

Standard	Assessed	Score	Comment
O10.1 Identify and describe pathogens that cause infectious disease.	Activity 3.1.3		
O10.2 Describe how the components of the human immune system fight disease and can be used in prevention and diagnosis.	Activity 3.1.3		

Cell Biology

Understanding the proper function of cells can help determine when something goes wrong.

Standard	Assessed	Score	Comment
O11.1 Explain how the composition, structure, and activities of cells build functional systems in the human body.	Activity 2.2.3, Activity 3.1.2		

Anatomy and Physiology

Biomedical scientists need to understand how the body functions in order to support patient health.

Standard	Assessed	Score	Comment
O12.1 Explain the connection between structure and function in biology.	Activity 1.2.6, Activity 2.2.6, Activity 3.2.3		
O12.2 Describe how the systems of the body work together to maintain homeostasis.	Activity 1.2.6, Activity 2.2.6		

Average Scale Score Across Multiple Goals	Traditional Grade
2.67-3.00	A
2.48-2.66	A/B
2.28-2.47	B
2.00-2.27	B/C
1.82-1.99	C
1.62-1.81	C/D
1.42-1.61	D
Below 1.41	F