Project Lead The Way [PLTW] Principles of Biomedical Science

PEIMS Code: N1302092

Abbreviation: PRBIOSCI

Grade Level(s): 9–12

Award of Credit: 1.0

Approved Innovative Course

- Districts must have local board approval to implement innovative courses.
- In accordance with Texas Administrative Code (TAC) §74.27, school districts must provide instruction in all essential knowledge and skills identified in this innovative course.
- Innovative courses may only satisfy elective credit toward graduation requirements.
- Please refer to TAC §74.13 for guidance on endorsements.

Course Description:

Principles of Biomedical Science (PBS) is a high school course providing foundational knowledge and skills in biology, anatomy & physiology, genetics, microbiology, and epidemiology; it engages students in applying knowledge and skills to real-world situations, cases, and problems. Students take on roles of different medical professionals and are challenged in various scenarios, including investigating a crime scene to solve a mystery, diagnosing and proposing treatment to patients in a family medical practice, tracking down and containing a medical outbreak at a local hospital, stabilizing a patient during an emergency, and collaborating with others to design solutions to local and global medical problems. Students develop skills in technical documentation to communicate experimental findings and solutions to problems. They explore how connections to other disciplines, such as computer science and engineering, shape the future of medicine. In addition, they demonstrate collaboration techniques that connect with professionals across any field.

Essential Knowledge and Skills:

(a) General Requirements. General Requirements. This course is recommended for students in grades 9th – 12th. There are no prerequisite courses required for enrollment in Principles of Biomedical Science. This course provides 1.0 unit of credit for successful completion of the course.

(b) Introduction.

(1) Principles of Biomedical Science (PBS) is a high school course providing foundational knowledge and skills in biology, anatomy and physiology, genetics, microbiology, and epidemiology as well as engaging students in applying knowledge and skills to real-world situations, cases, and problems.

(2) Students take on roles of different medical professionals and are challenged in various scenarios, including investigating a crime scene to solve a mystery, diagnosing and identifying treatment to patients in a family medical practice, tracking down and containing a medical

outbreak at a local hospital, stabilizing a patient during an emergency, and collaborating with others to design solutions to local and global medical problems.

(3) Students will develop skills in technical documentation to communicate experimental findings and solutions to problems, explore how connections to other disciplines, such as computer science and engineering, shape the future of medicine, and practice collaboration techniques that connect with professionals across any field.

(4) Students are encouraged to participate in extended learning experiences, such as career and technical student organizations and other leadership or extracurricular organizations.

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and Skills.

(1) Career Readiness: The student explains the education and skills required for biomedical science professionals and describes the societal impact of biomedical science professionals. The student is expected to:

(A) identify and describe the different careers of professionals who research, diagnose, and treat medical conditions;

(B) describe the education requirements, salary ranges, professional licensure, skills, and responsibilities of biomedical science professionals; and

(C) describe the impact that biomedical science research and interventions have on society.

(2) Communication: The student communicates effectively with a specific audience. The student is expected to

(A) apply acceptable formats identified by the instructor for writing assignments and professional presentations;

(B) modify technical and medical communications to meet the needs of the audience or patient;

(C) cite references for all reports in an accepted format identified by the instructor;

(D) demonstrate proper elements of written and electronic communication including spelling, grammar, and formatting in course deliverables;

(E) apply listening skills and interpret verbal and nonverbal behaviors to enhance communication with coworkers and patients;

(F) demonstrate technical communication practices by reading scientific journal articles, using databases, such as PubMed, NCBI, and writing scientific lab reports; and

(G) use appropriate scientific terminology and abbreviations in written and oral communications.

(3) Collaboration: The student creates an effective team environment to promote successful goal attainment. The student is expected to:

(A) explain the importance of demonstrating respect for others' viewpoints;

(B) demonstrate teamwork and describe the importance of each team member's contribution to the project;

(C) identify basic conflict resolution strategies and employ those strategies as necessary and appropriate;

(D) employ a peer review process to give effective and constructive feedback to meet given outcomes;

(E) develop a project schedule allocating tasks among team members and track progress for successful completion of the project; and

(F) select and use collaborative tools, such as cloud-based tools, document sharing, and video and text functions, to successfully complete a project.

(4) Ethical Reasoning and Mindset: The student applies professional standards as they relate to the personal traits of a biomedical science professional. The student is expected to:

(A) explain the importance of demonstrating professional standards such as creativity, perseverance, honesty, integrity, and accountability, that should be exhibited by biomedical professionals;

(B) create and support an environment that fosters teamwork, emphasizes quality, and promotes learning;

(C) explain the ethical implications of biomedical science decisions; and

(D) summarize and explain the larger ethical, moral, and legal issues related to scientific research, product development, and use in society animal use and human research.

(5) Critical and Creative Problem-Solving: The student devises and executes a plan to solve a problem, uses data and evidence to evaluate and justify decisions, and applies an iterative design process to creatively address a need or solve a problem. The student is expected to:

(A) synthesize information from multiple credible sources, such as literature, databases, policy documents, and diverse perspectives from multiple disciplines, to identify causes and solutions to problems;

(B) devise and execute a plan to solve a problem while considering the impacts of the possible solutions;

(C) use mathematical computations to interpret data;

(D) conduct research using credible resources to craft explanations and draw conclusions while acknowledging the limitations, opposing views, and biases;

(E) assess how design and innovation can help solve a problem in biomedical science;

(F) identify and define visual, functional, and structural design requirements and realistic constraints against which solution alternatives can be evaluated and optimized;

(G) describe how failure or unexpected results can produce positive outcomes by improving understanding;

(H) compare competing solution ideas and justify the selection of a solution path with respect to design requirements and constraints; and

(I) develop a solution and implement a plan to test and evaluate a potential solution to verify that it meets all constraints and complies with all design criteria.

(6) Experimental Design: The student designs and carries out an experiment that investigates a research question, collects, and analyzes experimental data, and draws conclusions. The student is expected to:

(A) develop a testable hypothesis and design an experimental protocol that evaluates its validity;

(B) distinguish between independent and dependent variables;

(C) identify and explain the purpose and importance of experimental controls;

(D) maintain a detailed repeatable account of an experiment in a physical or digital laboratory notebook;

(E) conduct background research using credible sources to identify and investigate a relevant research question;

(F) select and use equipment appropriately to conduct experiments;

(G) identify possible sources of errors and redesign and repeat the experiment when appropriate;

(H) communicate experimental findings with appropriate audiences both orally and in writing;

(I) explain how to accurately follow a lab protocol;

(J) display data appropriately and accurately in digital or written form, such as graphs, tables, and diagrams;

(K) perform necessary calculations to analyze experimental data; and

(L) draw logical conclusions from experimental data.

(7) General Laboratory Practices: The student demonstrates proficiency of general laboratory practice common to many biomedical science fields. The student is expected to:

(A) identify and apply principles of measurement;

(B) calculate concentrations and prepare solutions;

(C) develop and use a standard curve;

(D) demonstrate precise and accurate micro pipetting;

(E) demonstrate proper use of a microscope to view biological samples;

(F) demonstrate aseptic technique; and

(G) demonstrate successful culturing techniques.

(8) Anatomy and Physiology: The student explains the connection between structure and function in biology and describes how the systems of the body work together to maintain homeostasis. The student is expected to:

(A) describe the anatomy and physiology of key human body systems as well as the organization and interaction of those systems;

(B) explain how interactions between internal and external sources can affect body systems and cell functions;

(C) explain how organ anatomy, such as that of the heart or brain, is related to function;

(D) demonstrate how a change in structure in the body impacts its function;

(E) explain how body systems collaboratively function to maintain homeostasis and health;

(F) explain how feedback loops help maintain homeostasis in the body; and

(G) create, describe, and analyze models of biological processes to explain proper and improper functioning.

(9) Clinical Medicine: The student documents patient information, synthesizes complex medical information to diagnose a disease, disorder, or injury or to determine cause of death, and responds to patient and community needs and proposes treatment strategies for disease, disorder, injury, or the prevention thereof. The student is expected to:

(A) transcribe and communicate information, data, and observations using medical terminology;

(B) explain why it is important to maintain accurate patient records;

(C) explain professional practices in adherence to Health Insurance Portability and Accountability (HIPAA) guidelines to maintain patient privacy;

(D) demonstrate the correct procedure to collect, assess, and interpret patient vital signs;

(E) select and use appropriate diagnostic tools and tests to evaluate a patient's condition;

(F) explain the process of diagnosing and identifying treatments for patients;

(G) interpret medical information and laboratory test results to draw conclusions;

(H) identify causes of disease, such as environmental, genetic, or lifestyle, of health conditions;

(I) describe how a condition or disorder impacts body systems;

(J) identify a viable course of action to treat or manage a condition;

(K) demonstrate appropriate public health measures by proposing strategies for responding to health crises and disasters;

(L) describe the impact of lifestyle habits on human health and disease risk; and

(M) describe measures to prevent disease, disorder, or injury, such as regular doctor's visits and screening tests.

(10) Molecular Biology and Genetics: The student explains the role of DNA, RNA, and proteins in the inheritance of traits and the development of diseases or disorders and describes cell division and the process by which chromosomes replicate leading to genetic diversity. The student is expected to:

(A) describe the structure and function of nucleic acids and the relationship among genes, alleles, chromosomes, proteins, and traits;

(B) explain how the order and chemical properties of amino acids influence a protein’s structure and function;

(C) describe the processes of DNA replication and protein synthesis;

(D) explain how mutations in nucleic acids can lead to diseases or disorders or promote evolutionary change;

(E) demonstrate how environmental factors can lead to genetic mutations; and

(F) differentiate between mitosis and meiosis and model how these processes lead to genetic diversity.

(11) Molecular Biology and Genetics: The student analyzes genetic information to predict patterns of inheritance and selects and uses appropriate tools, techniques, and technologies to analyze genetic information and diagnose disease. The student is expected to:

(A) analyze karyotypes to diagnose chromosomal abnormalities;

(B) predict the pattern of gene inheritance using Punnett squares;

(C) predict the pattern of gene inheritance using pedigree analysis;

(D) explain and demonstrate techniques in molecular biology, such as DNA extraction, restriction digestion, gel electrophoresis, and interpret results; and

(E) use bioinformatics to analyze and compare genetic information.

(12) Microbiology: The student explains how the composition, structure, and activities of cells build functional systems in the human body. The student is expected to:

(A) differentiate between prokaryotic and eukaryotic cells;

(B) describe the relationship of cells, tissues, organs, and systems in the human body;

(C) identify the structure and function of macromolecules that are used in the body;

(D) demonstrate how the structure of the cell membrane impacts homeostasis; and

(E) explain the interaction between cells, their environment, and other cells.

Recommended Resources and Materials:

American Psychological Association. 2020. "Academic Writer Tutorial: Basics of Seventh Edition APA Style." https://extras.apa.org/apastyle/basics-7e/#/

Evans, C. (1996). "The Casebook of Forensic Detection: How Science Solved 100 of the World's Most Baffling Crimes." John Wiley and Sons, Inc.

Crime Scene. 2023. "Crime Scene: Previous Cases." https://www.crimescene.com/previous.

Directory of Open Access Journals. 2023. https://doaj.org/.

ProQuest. 2023. "Library Science Database." https://about.proquest.com/en/products-services/libraryscience.

Project Lead The Way Teacher and Student Resources. 2022. https://my.pltw.org/login.

Project Lead The Way Software and Technology Requirements. 2023. https://pltw.org/pltw-software.

Recommended Course Activities:

- Students will shadow members of the police department, the forensic investigation team, and the medical examiner as they document and analyze the clues left at the simulated scenes of two mysterious deaths. Both are based on real-world scenarios with explanations of practices and methods by real professionals.
- Students will work independently to explore a virtual crime scene, examine gathered evidence from the scene and witnesses, analyze evidence to deduce what happened, and complete an

autopsy report using test and examination results. In preparation for court testimony, students will create an evidence board that illustrates the case to a judge or jury.

- Students will assess and create plans of care for a series of patients via a digital patient portal. Each patient highlights key clinical skills and allows students to explore the way the human body works. Students will apply what they have learned to design a plan for a routine visit of a patient with a chronic health condition. Students explore the relationship between DNA, chromosomes, genes, and proteins and use what they learn to help a family interested in learning more about their genetic risk.
- Students will be tasked with helping a new patient at the simulated PLTW Total Care Clinic. Students need to evaluate all medical evidence, question the family, record vital signs, order and evaluate bloodwork, and synthesize data to make a diagnosis.
- Students will be called in to investigate a mysterious infection at a simulated local hospital. Students will work to determine why and how patients are getting sick and design a strategy for resolving the outbreak (and preventing another one).
- Students will take on the simulated role of an emergency medical response team, trained to respond when access to care is limited during accidents, natural disasters, and other mass casualty events. As they respond to an emergency in the field, students will investigate the assessment and stabilization of a patient, drug delivery and metabolism, techniques to stop bleeding, and communication between medical care providers.
- Students will plan the design of an app to trace outbreaks, respond to emergencies (local or global), increase response efficiency in emergencies, or provide another public health function.
- Students will engage in research and innovation activities with the various labs in this innovation incubator. Each lab they work with will challenge them to develop new skills and reinforce ones they have already practiced in the course. Students will practice the various steps of the design process, gain familiarity with tools and problem-solving techniques used in design, and participate in biomedical engineering activities.

Suggested methods for evaluating student outcomes:

PLTW supports a balanced approach to assessment for all programs. PLTW offers assessments that measure subject-matter knowledge as well as the in-demand, transportable skills that students need to succeed beyond high school. A sample of these assessment types are:

- Performance Assessments (example: Following Proper Protocols and Safety Procedures During Laboratory Experiments)
- Creation of Evidence Board for Virtual Crime Scene (to Illustrate a Case to a Judge/Jury) and Creation of An Autopsy Report (Autopsy Answer Keys Provided to the Teacher)
- Student Self Reflections
- Career Notebook Checks
- Project Checklists and Rubrics and Single-Point Rubrics
- Conclusion Questions at the End of Every Lesson (Answer Keys Provided to Teacher)
- Online Interim Assessments (by topic)
- Online Unit Assessments
- Online Summative End-of-Course Assessment

Teacher qualifications:

PLTW Principles of Biomedical Science Recommended Educator Certifications:

- Health Science: Grades 6-12 Health Science

- Health Science Technology: Grades 8-12
- Vocational Health Science Technology
- Secondary Biology (Grades 6-12)
- Secondary Science, Composite (Grades 6-12)
- Secondary Science (Grades 6-12)
- Life Science: Grades 7-12
- Life Science: Grades 8-12
- Legacy Master Science Teacher
- Mathematics/Physical Science/Engineering: Grades 6-12
- Mathematics/Physical Science/Engineering: Grades 8-12
- Science, Technology, Engineering, and Mathematics: Grades 6-12
- Science: Grades 7-12
- Science: Grades 8-12
- Chemistry: Grades 7-12
- Chemistry: Grades 8-12
- Secondary Chemistry (Grades 6-12)
- Trade and Industrial Education: Grades 6-12. This assignment requires appropriate work approval.
- Trade and Industrial Education: Grades 8-12. This assignment requires appropriate work approval.
- Vocational Trades and Industry (Grades 6-12). This assignment requires appropriate work approval.
- Vocational Health Occupations.

Additional information:

Successful completion of the Project Lead The Way's Core Training is required for Principles of Biomedical Science.

PLTW's Core Training for Principles of Biomedical Science requires approximately 90 hours of instruction led by PLTW approved Master Teachers (80 hours of class time plus 10 hours of prerequisite work). It is offered year-round with multiple options to allow teachers to select dates and pacing of their training session. Course mastery is demonstrated by the submission and approval of a course portfolio that meet's PLTW's requirements. After successful completion of Core Training, teachers receive access to the National PLTW Biomedical Science Professional Learning Community, course-specific student and classroom instructional resources, and ongoing training resources through the PLTW Content Management System.

Current details, such as pricing and listings for all PLTW professional development, can be found at https://www.pltw.org/our-programs/professional-development/core-training. At the time of this application submission, the course cost was* $2,400.

Note: Currently, PLTW offers a training guarantee to schools. The PLTW Training Guarantee protects a district's investment in PLTW programs by guaranteeing if a teacher leaves within four years of earning a PLTW credential, PLTW will provide a grant in the amount of the training fee for the district to train a teacher in the same course, replace the credential(s), and support continued student learning.

* PLTW Professional Development Fees are subject to change annually. Changes are communicated via email from PLTW Communications and on the PLTW website at least 90 days prior to the effective date for the upcoming school year. There are no changes for the 2023-24 school year.

Please contact Project Lead The Way directly for questions about these requirements:
Project Lead The Way
Solution Center Toll-Free: 877.335.PLTW (7589) solutioncenter@pltw.org