Project Lead The Way [PLTW] Biomedical Innovation

PEIMS Code: N1302095

Abbreviation: BIOINN

Grade Level(s): 11-12

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:

In Biomedical Innovation, students design innovative solutions for health challenges of the 21st century working through challenging open-ended problems, addressing topics such as clinical medicine, physiology, biomedical engineering, and public health. Students are presented with each problem in a mission file, a case brief, a list of completion tasks, links to resources, and a reflection section. This provides skills-based instruction in research and experimentation and tools students use to design innovative solutions to real-world problems. The student uses what they learn in these missions as they develop and implement their independent project at the end of the year, culminating in the creation of a project portfolio. Students are encouraged to work with a mentor from the biomedical industry and present their work to an audience from the health care community Recommended Prerequisites: At least one credit in a Level 2 or higher course in biomedical sciences.

Essential Knowledge and Skills:

(a) General Requirements. This course is recommended for students in grades 11 – 12. Recommended Prerequisites: At least one credit in a Level 2 or higher course in biomedical sciences. Students shall be awarded 1.0 credit for successful completion of this course.

(b) Introduction.

(1) In Biomedical Innovation, a capstone course, students design innovative solutions for health challenges of the 21st century working through challenging open-ended problems and addressing topics such as clinical medicine, physiology, biomedical engineering, and public health.

(2) Students are presented with each problem in a mission file, a case brief, a list of completion tasks, links to resources, and a reflection section. This information provides skills-based instruction in research and experimentation; tools students use to design innovative solutions to real-world problems.

(3) Students use what they learn in these missions as they develop and implement their independent project at the end of the year, culminating in the creation of a project portfolio. Students are encouraged to work with a mentor from the biomedical industry and present their work to an audience from the health care community.

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

(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) Experimental Design. The student independently designs an experiment which investigates a unique research question and analyzes self-collected data to draw a conclusion. The student is expected to:

(a) develop an experimental protocol that includes a testable hypothesis;

(b) distinguish between the independent and dependent variables within the experimental design;

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

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

(e) conduct background research using credible sources to support the development of a research question, hypothesis and experimental design;

(f) select and use appropriate equipment to conduct experiments;

(g) identify source of errors, then redesign and repeat the experiment when appropriate;

(h) communicate the findings of an experiment in oral and written (including digital) form;

(i) collaborate with a mentor who is an expert in their field to inform the development of a research question, hypothesis and experimental design;

(j) build a model, prototype, or schematic of proposed experimental design;

(k) describe why experimental design is a continual process;

(l) read and follow established experiment protocols and instructions;

(m) display experiment data appropriately and accurately in multiple formats (graphs, tables, diagrams);

(n) determine and perform appropriate calculations to analyze data based on the experiment; and

(o) communicate logical conclusions from experimental data.

(2) Critical and Analytical Thinking. The student investigates and solves a problem using analytical and critical thinking skills, explains the value of diverse perspectives and applies them to the

problem-solving process, and explains why scientists must have the courage to take a calculated risk. The student is expected to:

(a) create and execute a plan using analytical and critical thinking skills to solve a problem, for example, students will investigate health care delivery and propose innovations in clinical medicine;

(b) point out the importance of collecting data from multiple sources to solve a problem;

(c) explain how persistence is a key mindset when identifying problems and/or pursuing solutions;

(d) illustrate how iterative processes inform biomedical science decisions, improve solutions, and inspire new ideas;

(e) evaluate the reliability and credibility of sources when gathering information to solve problems;

(f) explain how solutions for complex problems can require interdisciplinary collaboration to incorporate a wide range of perspectives and skills;

(g) explain the importance of risk taking in performing experiments and developing solutions;

(h) classify the pros and cons associated with decisions made in biomedical science;

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

(j) explain how creativity can lead to scientific discovery.

(3) Biotechnology Tools and Technology. The student selects and uses appropriate tools, technology, and software for experimental and clinical data collection and analysis. The student is expected to:

(a) select appropriate technology and software for data collection;

(b) describe and identify cell and tissue features using a microscope;

(c) describe and demonstrate aseptic techniques for handling, culturing, and analyzing bacteria colonies;

(d) conduct investigations and analyze data using probes and software;

(e) conduct gel electrophoresis to separate deoxyribonucleic acid (DNA) fragments; and

(f) explain and apply results of gel electrophoresis.

(4) Efficient Systems. The student designs a medical space that is conducive to patient wellness and improves patient outcomes. The student is expected to:

(a) describe how medical innovations can reduce wait time in the emergency room;

(b) design an efficient emergency room to reduce patient wait time; and

(c) evaluate scenarios to determine how patient health issues are prioritized in an emergency room.

(5) Medical Innovations. The student creates or improves a medical innovation using a design process. The student is expected to:

(a) describe the impact of various medical innovations on human health; and

(b) explain the process of inventing and improving medical innovations.

(6) Statistics. The student uses statistics to solve biomedical science problems. The student is expected to:

(a) analyze data from two sample t-tests;

(b) explain how data can be manipulated in scientific studies;

(c) describe how scientific data is presented in the media and in scientific journals; and

(d) describe how statistics can be used inappropriately to manipulate data and/or mislead readers.

(7) Environmental Health and Safety. The student evaluates the impact of environmental factors on human health. The student is expected to:

(a) identify environmental concerns that are potentially harmful to health;

(b) explain how a range of factors affect how individuals respond to a given toxin;

(c) design and conduct water quality testing for the presence of contaminants;

(d) create an environmental health profile and action plan for the local area; and

(e) create and analyze a dose response model for the exposure of toxic chemicals.

(8) Public Health. The student analyzes health and disease data to inform public health decisions. The student is expected to:

(a) analyze medical evidence to diagnose a patient's health condition;

(b) analyze data from epidemiological studies to investigate the symptoms, pathogen, and transmission pattern of a mystery illness;

(c) identify medical interventions that can address global health issues;

(d) calculate measures of risk used to demonstrate an association between a risk factor and a disease; and

(e) describe how to set up case-control and cohort studies.

(9) Microbiology. The student uses proper techniques to identify strains of bacteria. The student is expected to:

(a) conduct water quality testing for the presence of coliforms and E. coli; and

(b) analyze bacterial deoxyribonucleic acid (DNA) using polymerase chain reaction (PCR) and gel electrophoresis to identify the strains of bacteria.

(10) Career Awareness. The student demonstrates awareness of the education and skills required for biomedical science professionals and of the societal impacts of biomedical science professionals. The student is expected to:

(a) identify and describe 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;

(c) explain the importance of life-long learning for biomedical science professionals;

(d) apply professional standards as they relate to the habits and characteristics of a biomedical science professional;

(e) describe the impact that biomedical science research and interventions have on disease prevention and treatment;

(f) describe the unique solutions to the health and medical problems of this century; and

(g) describe the global impact of biomedical science solutions.

(11) Career Awareness: The student demonstrates the use of project management to successfully and efficiently complete tasks as scheduled. The student is expected to:

(a) write a proposal for an independent project; including the elements "identify problem, literature review, methodology, materials, project schedule, and proposed product";

(b) establish a protocol, timeline, and a means to measure progress toward completion of a project;

(c) explain project timelines and progress of a project using a Gantt chart;

(d) research and compile information about a chosen topic within the scope of a managed project; and

(e) explain how breaking a large project into smaller tasks allows modifications to be made as necessary and serves to monitor progress toward completion of the project.

(12) Professionalism and Ethics. The student applies professional standards as they apply to the habits and characteristics of a biomedical science professional. The student is expected to:

(a) demonstrate the importance of honesty, integrity, and accountability for biomedical professionals;

(b) explain the importance of privacy for all individuals;

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

(d) describe the importance of ethical considerations when making biomedical science decisions;

(e) describe the ethics of human experimentation and the importance of informed consent; and

(f) explain the importance of punctuality and meeting deadlines.

(13) Communication. The student creates and delivers effective communication with specific audiences. The student is expected to:

(a) use acceptable formats for writing assignments and professional presentations;

(b) modify communications to meet the needs of the audience and be appropriate to the situation;

(c) properly cite references for all reports in an accepted format;

(d) use proper elements of written communication such as spelling, grammar, and formatting;

(e) write a mini grant to fund a proposal using a specified format such as the format utilized by National Institutes of Health;

(f) explain the advantages and disadvantages of using online resources; and

(g) prepare and present a poster displaying key information from a scientific study.

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

(a) demonstrate respect for others' viewpoints;

(b) describe the importance of each team member's contribution to the project;

(c) apply basic conflict resolution strategies and employ those strategies as necessary and appropriate; and

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

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.

Scitable by Nature Education. 2014. https://www.nature.com/scitable/.

Biotility. 2022. "Biotechnical Assistant Credentialing Exam." https://biotility.research.ufl.edu/bace/.

CDC COVID Data Tracker. (n.d.). Retrieved November 10, 2020, from https://covid.cdc.gov/covid-data-tracker/.

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

Project Lead The Way Software and Technology Requirements. 2022. https://pltw.org/pltw-software.

Recommended Course Activities:

- Students design an emergency department that takes efficient patient care to the next level.
- Students will work in teams to design, conduct, and analyze an experimental study to answer a question relating to one or multiple body systems that will potentially provide information to further advance the medical community.
- Students will work through the design process to design a biomedical innovation that can help improve or save lives and present a plan for how the product will be marketed.
- Students will work in teams to determine what is causing the symptoms and illness in the case study, perform water tests, explore the dose-response relationship of a toxin, investigate hazards in your local environment, create an environmental health profile of your community, and outline a plan to solve a local environmental health problem.
- Students take on the role of an epidemiologist from the state's health department to investigate a cluster of cases of unknown illness. Students must evaluate patient diagnostic test results to identify the mystery illness, assess evidence to deduce the source of the illness, design and analyze an epidemiological study to test the proposed source, and plan control and prevention efforts to limit future cases of the mystery illness. Students will then identify a local, national, or global public health crisis and write a mini-grant proposal, outlining an intervention plan.
- Students will design and work through a protocol to construct and clone recombinant DNA. Students will perform DNA ligation, linking DNA from two sources, and facilitate transformation of this recombinant DNA into bacterial cells, be responsible for gauging the success of your ligation through growth of bacteria containing the recombinant DNA and through restriction analysis of the completed plasmid. Students can then purify the plasmid, sequence, and analyze gene data, and submit their work to GenBank, the NIH genetic sequence database, for publication.
- In the role of forensic pathologist, students will examine a fetal pig using the same protocol as a human autopsy, including examination of the tissues, organs, systems, and body fluids, and to note any abnormalities. Students will then design a fictional death and highlight the clues left behind in the body to tell the story of how the person died with an autopsy report, medical history forms, and other documents of their choosing. Other student groups from within the BI classroom will be tasked with solving the mystery their peers create.
- Students will make a product, write a report, and make a formal oral presentation to an adult audience. The product may be the results and conclusion from a series of experiments, a prototype of a medical device, a multimedia diary of an internship experience, a school or community event that is a fundraiser or public service to raise awareness of a health issue.

Suggested methods for evaluating student outcomes:

PLTW supports a balanced approach to assessment for all programs. Each course offers opportunities for formative assessments such as rubrics, written responses to questions, written records of student work, discussions, and observations—whole group, small group, and individually.

A sample of these assessment types are:

- Self-Assessments and Peer Assessments
- Discussions and Observations
- Career Journal Reports
- Lab Reports
- Problem Rubrics
- Case Study Analysis
- Student Self Reflections
- Checklists
- Performance Checks (example: Dissections using proper protocols)
- Summative Assessments

Teacher qualifications:

PLTW Biomedical Innovation Recommended Educator Certifications

•Vocational Health Science Technology
•Health Science: Grades 6-12
•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. 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 Biomedical Innovation.

PLTW's Core Training for Biomedical Innovation 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 is *$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