Biomedical Innovations
14258

Rationale Statement: This course is designed to have a very flexible implementation. The teacher decides the best way to address the needs, desires, and resources of the students, teachers, and community. Students apply their knowledge and skills to answer questions or to solve problems related to the biomedical sciences. Students present the results of their work to an adult audience, which may include representatives from the local healthcare or business community or the school's PLTW partnership team. Students will work through progressively challenging open-ended problems, addressing topics such as: Clinical Medicine, Physiology, Biomedical Engineering, and Public Health. Students will play the role of an elite group of investigators dedicated to designing unique and innovative solutions to health challenges of the 21st century. Students will be introduced to each problem through a mission file that includes a case brief and mission statement. As students work through each mission, they will perform mission completion tasks.

Suggested grade level: Grades 11 or 12

Topics covered:

Design of an Effective Emergency Room
Exploring Human Physiology
Design of a Medical Innovation
Investigating Water Contamination
Combating a Public Health Issue
Molecular Biology in Action (optional)
Forensic Autopsy (optional)
Research Internship (optional)

Indicator #1: Design of an Effective Emergency Room	
Webb's Leveling	Standard and Examples
Recall	**BI 1.1** Brainstorm unique solutions to the health and medical problems of this century.
Recall	**BI 1.2** Complete a scavenger hunt as they explore online research tools and consider the composition of research articles.
Skill/Concept	**BI 1.3** Review how to summarize and document credible sources and review how to assess the integrity of information presented in Internet websites.
Strategic	**BI 1.4** Analyze the strengths and weaknesses of slide design

Thinking	in a PowerPoint presentation and reflect on presentations they have given in the past to compile a list of the components of an effective presentation.
Extended Thinking	**BI 1.5** Analyze the workings of an emergency room, discuss inefficiencies, and work with a team to design and construct a model for a more efficient emergency medicine delivery system.

Indicator #2: Exploring Human Physiology through Research Methods	
Webb's Leveling	Standard and Examples
Recall	**BI 2.1** Investigate the variety of research study designs available.
Skill/Concept	**BI 2.2** Explore what to look for when evaluating data presented by others.
Strategic Thinking	**BI 2.3** Evaluate which design is the most appropriate for the question being asked.
Strategic Thinking	**BI 2.4** Investigate the various ways in which data can be manipulated.
Strategic Thinking	**BI 2.5** Statistically analyze data.
Strategic Thinking	**BI 2.6** Use this process to analyze the results of a scientific investigation.
Extended Thinking	**BI 2.7** Design a small study related to human physiology.
Extended Thinking	**BI 2.8** Critique science data presented in popular media as compared with science data presented in scientific journals.
Extended Thinking	**BI 2.9** Use data acquisition software and available sensors, monitors, or probes, to find the answer to a question related to one or multiple body systems that students are interested in studying.

Indicator #3: Design a Medical Intervention	
Webb's Leveling	Standard and Examples
Recall	**BI 3.1** Investigate the evolution of various biomedical products.
Strategic Thinking	**BI 3.2** Brainstorm ideas for a new biomedical product or a way to improve an existing product.
Strategic Thinking	**BI 3.3** Research and compile information about their chosen problem, identified in the previous activity, and evaluate solutions of the past and present.
Extended Thinking	**BI 3.4** Explore possible design solutions, select the best approach, and develop a design proposal.
Extended	**BI 3.5** Showcase their design with a model, prototype, or

Thinking	schematic and create a marketing plan to pitch their product to potential investors.

Indicator #4: Investigating Water Contamination	
Webb's Leveling	Standard and Examples
Skill/Concept	**BI 4.1** Use a variety of chemical tests and a coliform culture test to detect contaminants in the water samples associated with the two case studies.
Skill/Concept	**BI 4.2** Use PCR and gel electrophoresis to determine whether there is coliform bacteria present in a water sample associated with a case study.
Strategic Thinking	**BI 4.3** Develop hypotheses of the most likely causes for the illnesses described in the two case studies and determine how they can test their hypotheses.
Strategic Thinking	**BI 4.4** Analyze a local water source to determine if contamination exists.
Extended Thinking	**BI 4.5** Devise a plan to prevent further contamination of the water sources and to possibly treat or purify the contaminated water described in the two case studies.
Extended Thinking	**BI 4.6** Evaluate if additional contamination hazards are present and develop a plan of action to prevent contamination.

Indicator #5: Combating a Public Health Issue	
Webb's Leveling	Standard and Examples
Skill/Concept	**BI 5.1** Investigate major health issues in the local area, across the United States, and around the globe.
Strategic Thinking	**BI 5.2** Evaluate patient diagnostic test results to identify the mystery illness.
Strategic Thinking	**BI 5.3** Assess evidence to deduce the source of the illness.
Strategic Thinking	**BI 5.4** Evaluate the types of interventions that would address various health issues.
Strategic Thinking	**BI 5.5** Identify where a comprehensive public health plan would have the greatest impact.
Strategic Thinking	**BI 5.6** Develop a plan that focuses on the treatment, prevention, or education surrounding the chosen health issue.
Strategic Thinking	**BI 5.7** Plan control and prevention efforts to limit future cases of the mystery illness.
Extended thinking	**BI 5.8** Design and analyze an epidemiological study to test the proposed source of an illness.
Extended Thinking	**BI 5.9** Design an intervention for a public health issue of their choosing.
Extended	**BI 5.10** Present a public health intervention plan in the form of

Thinking	a grant proposal.

Indicator #6: Molecular Biology in Action (optional)	
Webb's Leveling	Standard and Examples
Skill/Concept	**BI 6.1** Demonstrate how restriction analysis can be used to gauge the success of genetic engineering and gene cloning.
Skill/Concept	**BI 6.2** Complete a series of laboratory modules to clone and sequence glyceraldehyde 3-phosphate dehydrogenase (GAPDH), a gene involved in cellular respiration, in an uncharacterized plant species.
Strategic Thinking	**BI 6.3** Analyze the result of specific digestion of both linear and plasmid DNA.
Strategic Thinking	**BI 6.4** Complete a cloning experiment and assemble a new plasmid containing a resistance gene to the antibiotic kanamycin.
Strategic Thinking	**BI 6.5** Use restriction enzyme digestion and subsequent gel electrophoresis to analyze the results of their ligation.
Strategic Thinking	**BI 6.6** Isolate and define the GAPDH gene sequence.
Extended Thinking	**BI 6.7** Use logic and their knowledge of bioinformatics to piece together the genetic code for GAPDH.
Extended Thinking	**BI 6.8** Submit novel data to the National Institutes of Health Center for Biotechnology Information (NCBI) database, making the sequence data publically available in an international repository of genetic information.

Indicator #7: Forensic Autopsy (optional)	
Webb's Leveling	Standard and Examples
Skill/Concept	**BI 7.1** Examine a fetal pig using the same protocol as a human autopsy, including examination of the tissues, organs, systems, and body fluids; and note any abnormalities.
Strategic Thinking	**BI 7.2** Design a death and showcase the clues left behind in the body to tell the story of how a person died.
Extended Thinking	**BI 7.3** Solve the mystery that another group created and present the findings in an autopsy report.

Indicator #8: Research Internship (optional)	
Webb's Leveling	Standard and Examples
Extended Thinking	**BI 8.1** Work with a science research mentor in a 100-hour internship to determine an area of interest in the biomedical sciences.
Extended Thinking	**BI 8.2** Complete a literature review.

Extended Thinking	**BI 8.3** Write and carry-out the methodology for the project.
Extended Thinking	**BI 8.4** Analyze the results.
Extended Thinking	**BI 8.5** Present the results of their work to an adult audience.