Biomedical Innovation (BI) - PLTW

Curriculum/Content Area: Science	**Course Length**: 2 Terms
Course Title: Biomedical Innovation (BI) - PLTW	**Date last reviewed**: September 2017
Prerequisites: Medical Interventions (MI)	**Board approval date**: December 5, 2017
Primary Resource:	

Desired Results

Course description and purpose: In the final course of the PLTW Biomedical Science sequence, students build on the knowledge and skills gained from previous courses to design innovative solutions for the most pressing health challenges of the 21st century. Students address topics ranging from public health and biomedical engineering to clinical medicine and physiology. They have the opportunity to work on an independent design project.

Enduring Understandings:	**Essential Questions:**
1. Innovations in healthcare and medicine can promote efficiency in healthcare 2. Biomedical innovations rely on a variety of research studies. 3. Biomedical products provide solutions to medical problems. 4. Environment health impacts the quality of life. 5. Public health education plays an integral role in diagnosing and treating diseases 6.	1. Why is biomedical innovation important? 2. How are medical research and medical innovation related? 3. Why are different solutions explored while creating the biomedical innovation? 4. How do the conditions in the environment affect the human wellbeing? 5. What role does public health play in reducing risk factors and the development and spread of disease?

Unit 1: Problem One- Design of an Effective Emergency Room
Essential Questions: 1. Why is biomedical innovation important? 2. How are medical research and medical innovation related?
Standards:

Project Lead The Way Document with Standards Listed by Unit and Lesson

Cross-Cutting Concepts

Systems and System Models - Systems can be designed to do specific tasks.

Science and Engineering Practices

1. **Asking Questions and Defining Problems**
    - Ask questions
        - that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
        - that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
        - to determine relationships, including quantitative relationships, between independent and dependent variables.
    - to clarify and refine a model, an explanation, or an engineering problem.
    - Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.
    - Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.
2. **Developing and Using Models**
    - Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.
3. **Analyzing and Interpreting Data**
    - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
4. **Constructing Explanations and Designing Solutions**
    - Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past

and will continue to do so in the future.

- Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
- Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

5. **Engaging in Argument from Evidence**
    - Construct, use, and/or present an oral and written argument or counter arguments based on data and evidence.
    - Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.
6. **Obtaining, Evaluating, and Communicating Information**
    - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
    - Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
    - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.
    - Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Disciplinary Core Ideas

1. **ETS1.A: Defining and Delimiting Engineering Problems**
    a. Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2- 3)
2. **ETS1.B: Developing Possible Solutions**
    a. When evaluating solutions, it is important to take into account a range of

constraints, including cost, safety , reliability , and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

3. **ETS1.C: Optimizing the Design Solution**
    a. Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)

Learning Targets:

1. I can describe unique solutions to the health and medical problems of this century and produce effective oral and visual presentations.
2. I can predict how innovations in healthcare and medicine would help reduce wait time and promote efficient care in emergency rooms and emergency care centers.
3. I can use online search engines and journal databases to locate scientific articles.
4. I can analyze the format of a presentation and list strengths and weaknesses in design.
5. I can design an efficient emergency room or department.
6. I can produce a Gantt chart to manage the work of a design project and create and execute an effective formal presentation.

Assessment Evidence:

Performance Assessment Options	Other assessment options
May include, but are not limited to the following: ● Lab Experiments ● Lab Journals	*May include, but are not limited to the following:* ● Unit Assessment

Digital Tools & Supplementary Resources:

- Vernier probeware and software
- Inspiration
- Edvotek Gel Electrophoresis Machinery

Unit Title: Problem 2 - Exploring Human Physiology

Essential Questions:

1. Why is biomedical innovation important?
2. Why are different solutions explored while creating the biomedical innovation?

Standards:

[Project Lead The Way Document with Standards Listed by Unit and Lesson]

Cross-Cutting Concepts

1. **Patterns -** Mathematical representations are needed to identify some patterns.
2. **Cause and Effect** - Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
3. **Scale, Proportion, and Quantity -** Algebraic thinking is used to examine scientific data and predict the effect of a change

Science and Engineering Practices

1. **Asking Questions and Defining Problems**
    - Ask questions
        - that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
        - that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
        - to determine relationships, including quantitative relationships, between independent and dependent variables.
        - to clarify and refine a model, an explanation, or an engineering problem.
    - Evaluate a question to determine if it is testable and relevant.
    - Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
    - Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.
2. **Planning and Carrying Out Investigations**
    - Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.
    - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.
    - Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal

impacts.
  - Select appropriate tools to collect, record, analyze, and evaluate data. Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

3. **Analyzing and Interpreting Data**
    - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
    - Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
    - Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.
    - Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.
4. **Using Mathematics and Computational Thinking**
    - Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.
    - Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
5. **Constructing Explanations and Designing Solutions**
    - Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
    - Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
    - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
    - Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
    - Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
6. **Engaging in Argument from Evidence**
    - Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.
    - Construct, use, and/or present an oral and written argument or

counter-arguments based on data and evidence.
  - Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

7. **Obtaining, Evaluating, and Communicating Information**
   - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
   - Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
   - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.
   - Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Disciplinary Core Ideas

1. **LS1.A: Structure and Function**
   - **a.** Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
   - **b.** Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)

Learning Targets:

1. I can recognize that statistics can be used inappropriately to manipulate data and/or mislead readers and generalize how such statistical research presented in the popular media can differ from research results presented in scientific literature.
2. I can produce a brief study design to investigate the association between an activity/treatment and disease pair.
3. I can design, conduct and analyze a controlled experiment and can produce statistical analysis for such an assigned study.
4. I can create and present a poster presentation to display results of an experimental study.

Assessment Evidence:	
Performance Assessment Options *May include, but are not limited to the following:* ● Lab Experiments ● Lab Journals	**Other assessment options** *May include, but are not limited to the following:* ● Unit Assessment
Digital Tools & Supplementary Resources:	
● Vernier probeware and software ● Inspiration ● Edvotek Gel Electrophoresis Machinery	

Unit Title: Problem 3 - Design of a Medical Innovation

Essential Questions:

1. Why is biomedical innovation important?
2. How are medical research and medical innovation related?
3. Why are different solutions explored while creating the biomedical innovation?
4. How do the conditions in the environment affect the human wellbeing?

Standards:

Project Lead The Way Document with Standards Listed by Unit and Lesson

Cross-Cutting Concepts

1. **Patterns -** Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.
2. **Cause and Effect** - Systems can be designed to cause a desired effect.
3. **Systems and Models -** Systems can be designed to do specific tasks.
4. **Structure and Function -** The way an object is shaped or structured determines many of its properties and functions. The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Science and Engineering Practices

1. **Asking Questions and Defining Problems**
    - Ask questions
        - that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
        - that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

        - to determine relationships, including quantitative relationships, between independent and dependent variables.
        - to clarify and refine a model, an explanation, or an engineering problem.
    - Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.
2. **Developing and Using Models**
    - Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.
3. **Planning and Carrying Out Investigations**
    - Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.
4. **Analyzing and Interpreting Data**
    - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
    - Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
5. **Using Mathematics and Computational Thinking**
    - Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.
    - Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
6. **Constructing Explanations and Designing Solutions**
    - Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
    - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
    - Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
    - Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
7. **Engaging in Argument from Evidence**

- Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
- Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.
- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

8. **Obtaining, Evaluating, and Communicating Information**
   - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
   - Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
   - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.
   - Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

<u>**Disciplinary Core Ideas**</u>

1. **ETS1.A: Defining and delimiting Engineering Problems**
   a. Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3)
   b. Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)
2. **ETS1.B: Developing Possible Solutions**
   a. When evaluating solutions, it is important to take into account a range of constraints, including cost, safety , reliability , and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)
3. **ETS1.C: Optimizing the Design Solution**

a. Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)

Learning Targets:

1. I can describe the evolution of various biomedical products, such as an insulin pump or artificial skin.
2. I can recognize that when designing a solution to a problem, all criteria need to be specified and all possible designs need to be explored.
3. I can develop ideas for a new biomedical product or for a way to improve an existing product.
4. I can research and compile information about a chosen problem and evaluate solutions of the past and present.
5. I can propose possible design solutions, select the best approach, and develop a design proposal and then create a model, prototype, or schematic for the chosen solution.

Assessment Evidence:

Performance Assessment Options	Other assessment options
May include, but are not limited to the following: ● Lab Experiments ● Lab Journals	*May include, but are not limited to the following:* ● Unit Assessment

Digital Tools & Supplementary Resources:

- Vernier probeware and software
- Inspiration
- Edvotek Gel Electrophoresis Machinery

Unit Title: Problem 4 - Investigating Environmental Health

Essential Questions:

1. How do the conditions in the environment affect the human wellbeing?

Standards:

Project Lead The Way Document with Standards Listed by Unit and Lesson

Science and Engineering Practices

1. **Asking Questions and Defining Problems**
   - Ask questions
     - that arise from careful observation of phenomena, or unexpected

results, to clarify and/or seek additional information.
        - that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
        - to determine relationships, including quantitative relationships, between independent and dependent variables.
        - to clarify and refine a model, an explanation, or an engineering problem.

2. **Analyzing and Interpreting Data**
    - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
3. **Constructing Explanations and Designing Solutions**
    - Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
    - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
    - Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
4. **Engaging in Argument from Evidence**
    - Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
    - Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.
5. **Obtaining, Evaluating, and Communicating Information**
    - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
    - Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
    - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.
    - Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media

reports, verifying the data when possible. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Disciplinary Core Ideas

1. **PS1.B: Chemical Reactions**
   a. The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2), (HS-PS1-7)
2. **LS2.C: Ecosystem Dynamics, Functioning, and Resilience**
   a. Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)
3. **LS3.B: Variation of Traits**
   a. Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2), (HS-LS3-3)

Learning Targets:

1. I can predict how environmental concerns/toxins are harmful to public health and explain how those toxins can affect individual responses to such exposures.
2. I can recognize that the presence of coliform in water indicates contamination with human or animal fecal material and that disease-causing agents may be present.
3. I can recognize that an environmental health profile outlines the quality of the local environment and the health of local residents.
4. I can perform and analyze a culture assay to detect coliform and E. Coli in water and use PCR, gel electrophoresis and variety of chemical assays to determine bacterial strains and contaminants present in a simulated water sample.
5. I can design and conduct an experiment to test the effects of a particular chemical and doses of that chemical on plant growth and produce graphical analysis of the data collected.
6. I can compile a comprehensive environmental health profile for the local area and design an action plan to increase awareness, monitor resources or individuals in the community, improve conditions, and ensure a clean and safe environment.

Assessment Evidence:

Performance Assessment Options
May include, but are not limited to the following:

- Lab Experiments
- Lab Journals

Digital Tools & Supplementary Resources:

- Vernier probeware and software
- Inspiration
- Edvotek Gel Electrophoresis Machinery

Unit Title: Problem 5 - Combating a Public Health Issue

Essential Questions:

1. What role does public health play in reducing risk factors and the development and spread of disease?

Standards:

Project Lead The Way Document with Standards Listed by Unit and Lesson

Science and Engineering Practices

1. **Asking Questions and Defining Problems**
    - Ask questions
        - that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
        - that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
        - to determine relationships, including quantitative relationships, between independent and dependent variables.
        - to clarify and refine a model, an explanation, or an engineering problem.
2. **Analyzing and Interpreting Data**
    - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
3. **Constructing Explanations and Designing Solutions**
    - Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
    - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
    - Apply scientific reasoning, theory, and/or models to link evidence to the claims

to assess the extent to which the reasoning and data support the explanation or conclusion.
   - Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
4. **Engaging in Argument from Evidence**
   - Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
   - Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.
5. **Obtaining, Evaluating, and Communicating Information**
   - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
   - Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
   - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.
   - Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Disciplinary Core Ideas

1. **LS1.A: Structure and Function**
   a. Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)

Learning Targets:

1. I can recognize that measures of association such as relative risk and the odds ratio describe the correlation between specific risk factors and the development of disease.
2. I can describe how to set up case-control and cohort studies.
3. I can recognize local, national, and global disease trends and analyze evidence documents to determine the source of a disease outbreaks.
4. I can calculate measures of risk used to demonstrate a possible association between

a risk factor and a disease.
5. I can write a grant proposal outlining an intervention plan for a particular disease, illness, or injury and present and defend my intervention plan to a professional audience.

Assessment Evidence:

Performance Assessment Options
May include, but are not limited to the following:
- Lab Experiments
- Lab Journals

Other assessment options
May include, but are not limited to the following:
- Unit Assessment

Digital Tools & Supplementary Resources:

- Vernier probeware and software
- Inspiration
- Edvotek Gel Electrophoresis Machinery

Unit Title: Problem 6 - Molecular Biology in Action

Essential Questions:
- Why is biomedical innovation important?
- How are medical research and medical innovation related?
- Why are different solutions explored while creating the biomedical innovation?

Standards:

Project Lead The Way Document with Standards Listed by Unit and Lesson

Science and Engineering Practices

1. **Asking Questions and Defining Problems**
   - Ask questions
     - that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
     - that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
       1. to determine relationships, including quantitative relationships, between independent and dependent variables.
   - to clarify and refine a model, an explanation, or an engineering problem.
2. **Analyzing and Interpreting Data**
   - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

3. **Constructing Explanations and Designing Solutions**
    - Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
    - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
    - Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
4. **Engaging in Argument from Evidence**
    - Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
    - Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.
5. **Obtaining, Evaluating, and Communicating Information**
    - Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
    - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.
    - Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Disciplinary Core Ideas

1. **LS1.A: Structure and Function**
    a. Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
    b. All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1), (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)
    c. Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)

2. **LS1.C: Organization for Matter and Energy Flow in Organisms**
    a. The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6)
3. **LS3.A: Inheritance of Traits**
    a. Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1)

Learning Targets:

1. I can recognize that plasmids cut with restriction enzymes can be joined or ligated to DNA (from any species) and explain how the DNA inserted into a plasmid may provide the code for a new protein.
2. I can recognize that the results of a ligation experiment can be gauged by restriction analysis of an extracted plasmid and subsequent visualization of resultant bands via electrophoresis.
3. I can map a plasmid in terms of the location of their restriction sites, sites that are recognized and cut by specific restriction enzymes.
4. I can predict the results of a ligation experiment and then ligate DNA from two organisms to create a unique plasmid vector.
5. I can produce a new plasmid into bacterial cells through the process of bacterial transformation.

Assessment Evidence:

Performance Assessment Options	**Other assessment options**
May include, but are not limited to the following: ● Lab Experiments ● Lab Journals	*May include, but are not limited to the following:* ● Unit Assessment

Digital Tools & Supplementary Resources:

- Vernier probeware and software
- Inspiration
- Edvotek Gel Electrophoresis Machinery

Unit Title: Problem 7- Forensic Autopsy/Independent Project

Essential Questions:

1. Why is biomedical innovation important?
2. Why are different solutions explored while creating the biomedical innovation?

Standards:

Project Lead The Way Document with Standards Listed by Unit and Lesson

Cross-Cutting Concepts

1. **Patterns -** Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.
2. **Cause and Effect** - Changes in systems may have various causes that may not have equal effects.
3. **Structure and Function -** A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. The way an object is shaped or structured determines many of its properties and functions. The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Science and Engineering Practices

1. **Asking Questions and Defining Problems**
    - Ask questions
        - that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
        - that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
        - to determine relationships, including quantitative relationships, between independent and dependent variables.
        - to clarify and refine a model, an explanation, or an engineering problem.
2. **Analyzing and Interpreting Data**
    - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
3. **Constructing Explanations and Designing Solutions**
    - Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
    - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible

unanticipated effects.
  - Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

4. **Engaging in Argument from Evidence**
   - Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
   - Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.
5. **Obtaining, Evaluating, and Communicating Information**
   - Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
   - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.
   - Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Disciplinary Core Ideas

1. **LS1.A: Structure and Function**
   a. Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
   b. Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)

Learning Targets:

1. I can recognize that size measurements and weights of organs are used in an autopsy to determine any abnormalities.
2. I can generalize the cause of death being natural, accident, or homicide, and showcase how a body leaves clues to tell the story of how a person died.
3. I can complete a fetal pig autopsy using the same protocol used for humans, including examination of the tissues, organs, systems, and body fluids.
4. I can create a fictitious death scenario, including an autopsy report and medical history forms, to illustrate cause of death.
5. I can analyze a fictitious death scenario, including an autopsy report and medical

history forms, to determine cause of death.

Assessment Evidence:

Performance Assessment Options	**Other assessment options**
May include, but are not limited to the following: ● Lab Experiments ● Lab Journals	*May include, but are not limited to the following:* ● Unit Assessment ● End of Course Assessment

Digital Tools & Supplementary Resources:

- Vernier probeware and software
- Inspiration
- Edvotek Gel Electrophoresis Machinery

Unit Title: Problem 8 - Independent Project (OPTIONAL)

- A long-term project requires planning in order to have the proper materials and to schedule the work to be completed on time.

Standards:

Project Lead The Way Document with Standards Listed by Unit and Lesson

Cross-Cutting Concepts

1. **Patterns -** Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.
2. **Cause and Effect** - Systems can be designed to cause a desired effect.
3. **Scale, Proportion, and Quantity -** Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
4. **Systems and System Models -** Systems can be designed to do specific tasks. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
5. **Structure and Function -** The way an object is shaped or structured determines many of its properties and functions. The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Science and Engineering Practices

1. **Asking Questions and Defining Problems**
    - Ask questions

        - that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
        - that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
        - to determine relationships, including quantitative relationships, between independent and dependent variables.
        - to clarify and refine a model, an explanation, or an engineering problem.
    - Evaluate a question to determine if it is testable and relevant.
    - Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
    - Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.
    - Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.
2. **Developing and Using Models**
    - Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.
    - Design a test of a model to ascertain its reliability.
    - Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
    - Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.
    - Develop a complex model that allows for manipulation and testing of a proposed process or system.
    - Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
3. **Planning and Carrying Out Investigations**
    - Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.
    - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types,

how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.
  - Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.
  - Select appropriate tools to collect, record, analyze, and evaluate data. Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

4. **Analyzing and Interpreting Data**
  - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
  - Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
  - Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.
  - Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.
  - Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.
5. **Using Mathematical and Computational Thinking**
  - Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.
  - Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.
  - Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
6. **Constructing Explanations and Designing Solutions**
  - Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
  - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
  - Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

7. **Engaging in Argument from Evidence**
    - Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
    - Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
    - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
    - Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
    - Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
8. **Obtaining, Evaluating, and Communicating Information**
    - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
    - Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
    - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.
    - Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Learning Targets:

1. I can recognize that breaking a large project into many smaller tasks allows for modifications to be made as necessary and serves as a means to monitor progress toward completion of the project.
2. I can use appropriate Internet search techniques to gather information about a topic from appropriate websites.
3. I can develop a proposal for an independent project.

4. I can establish a protocol, timeline, and a means to measure progress toward completion of the project.
5. I can complete an independent project, including making a product, writing a report, compiling a portfolio, and delivering an oral presentation.