Principles of Biomedical Science (PBS) - PLTW

Curriculum/Content Area: Science	**Course Length:** 2 terms
Course Title: Principles of Biomedical Science (PBS) - PLTW	**Date last reviewed:** September 2017
Prerequisites: Biology (or Concurrent Enrollment)	**Board approval date:** December 5, 2017
Primary Resource:	

Desired Results

Course description and purpose: This course provides an introduction to the biomedical sciences through exciting hands-on projects and problems. Students investigate the human body systems and various health conditions including heart disease, diabetes, sickle-cell disease, hypercholesterolemia, and infectious diseases. They determine the factors that led to the death of a fictional person, and investigate lifestyle choices and medical treatments that might have prolonged the person's life. The activities and projects introduce students to human physiology, medicine, research processes and bioinformatics. Key biological concepts including homeostasis, metabolism, inheritance of traits, and defense against disease are embedded in the curriculum. Engineering principles including the design process, feedback loops, and the relationship of structure to function are also incorporated. This course is designed to provide an overview of all the courses in the Project Lead the Way Biomedical Sciences program and lay the scientific foundation for subsequent courses. (*Project Lead The Way*)

Enduring Understandings:	**Essential Questions**:
1. Principles of biomedical science can be used to investigate the circumstances surrounding a death. 2. Diabetes is a disorder characterized by high blood glucose levels and caused by insufficient insulin or the inability of the insulin to function properly.	1. How can a crime scene be evaluated to determine death? 2. How can hormones affect body system function? 3. How will structure affect the function of red blood cells? 4. How will blood flow through the heart and around the body?

3. Sickle cell disease and anemia cause many health problems and affect daily life for someone with the disease. 4. The human heart is a four-chambered muscular pump designed to provide the force needed to transport blood through all the tissues of the body. 5. Infectious diseases are caused by infectious agents and are transmitted in a variety of manners. 6. The human body is composed of multiple systems working together to maintain good health.	• How are infectious diseases transmitted? • How will the interconnected body systems function as one unit?

Unit 1: The Mystery

Major Topics:

A. Investigating a Crime Scene
B. DNA Analysis
C. Autopsy

Standards:

PLTW Document with Standards Listed by Unit and Lesson

Cross-Cutting Concepts:

1. **Patterns -** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
2. **Cause and Effect** - Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Changes in systems may have various causes that may not have equal effects.
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 -** A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. 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. Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

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.
6. **Stability and Change -** Much of science deals with constructing explanations of how things change and how they remain stable.

<u>**Science and Engineering Practices**</u>

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.
    - Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
    - Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.
    - Ask questions 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.
2. **Developing and Using Models**
    - 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.
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.
6. **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.
7. **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.
    - 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)
    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

Learning Targets:

1. I can recognize that processing a crime scene involves purposeful documentation of the conditions at the scene and the collection of any physical evidence.
2. I can describe how evidence at a crime scene, such as hair, fingerprints, shoeprints and blood can help forensic investigators determine what might have occurred and help identify or exonerate potential suspects and analyze key information gathered at a crime scene.
3. I can design a controlled experiment and recognize that all external variables in an experiment need to be controlled.
4. I can describe the relationship between DNA, genes, and chromosomes and can model the structure of DNA its nucleotides.
5. I can explain how restriction enzymes work to specifically cut DNA and describe how gel electrophoresis separates those DNA fragments and recognize that gel electrophoresis can be used to examine DNA differences between individuals.
6. I can describe how an autopsy is performed and the types of information it provides to officials regarding the manner and cause of death. Furthermore, I can interpret and predict information from an autopsy report to predict the manner of death.
7. I can explain the importance of confidentiality when dealing with patients, and describe the major patient protections written into the Health Insurance Portability and Accountability Act (HIPAA) and analyze patient confidentiality scenarios and discuss the legalities.

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 2: Diabetes

Major Topics:

A. What is diabetes
B. The science of food
C. Life with diabetes

Standards:

PLTW Document with Standards Listed by Unit and Lesson

Cross-Cutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Cause and Effect

- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
- Changes in systems may have various causes that may not have equal effects.

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).

Systems and System Models

- A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
- 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.
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Energy and Matter:

- Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
- The total amount of energy and matter in closed systems is conserved.
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.
- Energy drives the cycling of matter within and between systems.

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.

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.
- Feedback (negative or positive) can stabilize or destabilize a system.

<u>Science and Engineering Practices</u>

Asking questions and defining problems

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

Developing and Using Models

- Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

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.
- 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.

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.

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.

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.

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).

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

LS1.A: Structure and Function

- Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
- 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)
- Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

LS1.C: Organization for Matter and Energy Flow in Organisms

- 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)
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6), (HS-LS1-7)
- As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)

PS1.A: Structure and Properties of Matter

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1)
- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)

PS3.A: Definitions of Energy

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1), (HS-PS3-2)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy . (HSPS3-2), (HS-PS3-3)

PS3.B: Conservation of Energy and Energy Transfer

- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4)
- The availability of energy limits that can occur in any system. (HS-PS3-1)

- Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)

ETS1.B: Developing Possible Solutions
- 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)

ETS1.C: Optimizing the Design Solution
- 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 compare and contrast Type 1 and Type 2 diabetes and explain the feedback mechanisms of insulin and glucagon in maintaining homeostasis of blood glucose levels.
2. I can construct and present a model of how insulin and glucagon work to regulate blood/glucose levels and showcase the physiology behind the feedback process.
3. I can describe the nutritional content of foods and describe foods that are high in carbohydrates, lipids, and proteins along with their molecular structure.
4. I can analyze food labels and food choices for nutritional content and identify what indicators identify a proper and healthy food choice based off of label percentages.
5. I can identify a wide variety of treatments, management practices and medical interventions that are available to diabetics, and advise a patient newly diagnosed with diabetes on treating and living with the disease.
6. I can model how diabetes affects how water moves across a cell membrane to affect balance of dissolved solute levels on either side, and relate this to interactions of human body tissues.
7. I can showcase multiple complications of diabetes on several human body systems and explain the physiology of how diabetes affects those systems specifically.

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 3: Sickle Cell Disease

Major Topics:

A. Sickle Cell Disease (SCD)
B. Genetics of SCD
C. Chromosomal Defects with SCD
D. Inheritance

Standards:

[PLTW Document with Standards Listed by Unit and Lesson]

Cross-Cutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Cause and Effect

- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
- Changes in systems may have various causes that may not have equal effects.

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).

Systems and System Models

- A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
- 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.
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

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.

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

Science and Engineering Practices

Asking questions and defining problems

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

- Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.
- Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Developing and Using Models

- Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Planning and Carrying Out Investigations

- 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.

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.

Using Mathematics and Computational Thinking

- Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3 , acre-feet, etc.)
- 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.

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.

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.

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

LS1.A: Structure and Function

- Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
- 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),
- 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)

HS.ETS1.4: Engineering Design

- Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

LS1.B: Growth and Development of Organisms

- In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)

LS1.C: Organization for Matter and Energy Flow in Organisms

- 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)

LS3.A: Inheritance of Traits

- 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)

LS3.B: Variation of Traits

- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2)

LS4.B: Natural Selection

- Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2), (HS-LS4-3)
- The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)

Learning Targets:

1. I can explain the structure and function of each of the major components of blood.
2. I can demonstrate how sickle-shaped red blood cells lead to decreased oxygen flow to body tissues and other body complications.
3. I can explain how the structures and functions of proteins can be altered by amino acids.
4. I can model a simulated protein through the processes of transcription and translation and identify this process at a molecular level.
5. I can model the processes of mitosis and meiosis.
6. I can explain the differences in somatic cell chromosomes and gamete cell chromosomes within the human genome.
7. I can create and process family pedigrees to determine the mode of inheritance of genetic diseases.
8. I can analyze pedigrees to calculate the probability of inheriting a trait or disease and explain the outcomes to families and patients.

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 4: Heart Disease
Major Topics A. Heart Structure B. The Heart at Work C. Heart Dysfunction D. Intervention and Treatment
Standards:
PLTW Document with Standards Listed by Unit and Lesson **<u>Cross-Cutting Concepts:</u>** **Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. **Cause and Effect** • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Changes in systems may have various causes that may not have equal effects. **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). **Systems and System Models** • A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. • 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. • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. **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. **Stability and Change**

- Much of science deals with constructing explanations of how things change and how they remain stable.

<u>Science and Engineering Practices</u>

Asking questions and defining problems

- Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
- Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
- Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.
- Ask questions 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.

Developing and Using Models

- Design a test of a model to ascertain its reliability.
- 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.

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.

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.

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.

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.

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).

<u>Disciplinary Core Ideas</u>

LS1.A: Structure and Function

- Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
- 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)

- 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)

ETS1.B: Developing Possible Solutions

- 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)

ETS1.C: Optimizing the Design Solution

- 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 identify the main structures of the heart and describe their functions.
2. I can compare the structure and function of arteries and veins.
3. I can explain the physiology behind how and why a heart beats rhythmically and analyze EKG information to predict abnormalities.
4. I can explain how blood pressure relates to heart function and predict how changes in blood pressure affect heart function.
5. I can design controlled experiments to test the effects that exercise, body position, diet or stress can have on heart rate and blood pressure.
6. I can generalize how the relationship between cholesterol ratios of LDL, HDL and triglyceride levels can impact blood flow throughout arteries.
7. I can conduct and analyze the results of a gel electrophoresis to correctly diagnose a disorder for a patient.
8. I can describe the function of an angiogram and make predictions about the health of a patient based on the visual appearance of an angiogram.
9. I can analyze heart disease risk and design a risk reduction program.
10. I can demonstrate techniques used to open a blocked heart vessel: angioplasty, stent, coronary bypass procedure.

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 5: Infectious Disease
Major Topics: A. Infection
Standards:
[PLTW Document with Standards Listed by Unit and Lesson] **Cross-Cutting Concepts:** **Patterns** ● Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. **Cause and Effect** ● Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. ● Changes in systems may have various causes that may not have equal effects. **Systems and System Models** ● A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. ● 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. ● Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. **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. **Stability and Change** ● Much of science deals with constructing explanations of how things change and how they remain stable. **Science and Engineering Practices** **Asking questions and defining problems** ● Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. ● Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships. ● Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. ● Ask questions to clarify and refine a model, an explanation, or an engineering

problem.

Developing and Using Models

- 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.

Planning and Carrying Out Investigations

- 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.

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.

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.

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.

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

LS1.A: Structure and Function

- Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
- 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 demonstrate the mode of transmission and reproduction of various infectious agents and model how to reduce exposure to those agents, along with identifying appropriate treatment for such infectious agents.
2. I can compare and contrast the biology and pathology of various infectious agents: virus, bacteria, fungus, protists, helminths and prions.
3. I can compare and contrast the basic structures of a bacterial cell, specifically Gram positive vs. Gram negative bacterial cells.
4. I can explain and practice proper aseptic technique to isolate bacterial colonies for research and study.
5. I can perform a gross morphological examination of bacterial colonies to differentiate an unknown bacterial sample.
6. I can perform a proper Gram staining and utilize microscope techniques to observe, and classify bacteria.
7. I can explain the importance of biochemical tests that need to be clinically done in order to properly examine and identify unknown bacteria or pathogens.
8. I can predict how the immune system responds when an antigen enters the body by comparing and contrasting the non specific immune response (skin, phagocytes, neutrophils, basophils…..etc.) vs. the specific immune response (T-cell, B-cell, M-cell, KT-cell….etc.)

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:

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- Inspiration
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Unit 6: Post Mortem

Major Topics

A. Analyzing Death

Standards:

PLTW Document with Standards Listed by Unit and Lesson

Cross-Cutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Cause and Effect

- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
- Changes in systems may have various causes that may not have equal effects.

Systems and System Models

- A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

Structure and Function

- The way an object is shaped or structured determines many of its properties and functions.

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

Science and Engineering Practices

Asking questions and defining problems

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

Planning and Carrying Out Investigations

- 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.

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.

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<u>Disciplinary Core Ideas</u>

LS1.A: Structure and Function

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- 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 explain the many structures and functions found within different human body systems. 2. I can describe how all the human body systems are interconnected and how those interactions are necessary for life the function properly. 3. I can analyze autopsy reports and medical history documents to predict cause of death.	
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 ● End of Course Exam
Digital Tools & Supplementary Resources:	
● Vernier probeware and software ● Inspiration ● Edvotek Gel Electrophoresis Machinery	