School District of Marshfield Course Syllabus

Course Name: Principles of the Biomedical Sciences PS PLTW
Length of Course: Year
Credit: 1 Credit

Program Goal:

The School District of Marshfield K-12 Science Program will prepare and motivate learners to explore, problem solve and collaborate with their classmates to interpret science and explain the world around them. Learners will acquire knowledge and evidence that promotes creative solutions through the evaluation and understanding of scientific theories and evidence. Learners will collect, analyze and reason with scientific data through investigations that ultimately allow for the generation of scientific explanations. Critical thinking skills will elevate natural curiosity, make sense of scientific data and promote scientific literate citizens.

Course Description:

Principles of Biomedical Science is a full-year high school course in the PLTW Biomedical Science program. This course serves to provide foundational knowledge and skills in fields such as biology, anatomy and physiology, genetics, microbiology and epidemiology, as well as engage students in how they can apply this content to real-world situations, cases and problems such as solving a medical mystery case, diagnosing and treating a patient, or responding to a medical outbreak.

Common Core State Standards for English Language Arts Anchor Standards (AS)

Reading (R)

- AS.R.1 Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
- AS.R.4 Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.
- AS.R.7 Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.
- AS.R.8 Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.
- AS.R.10 Read and comprehend complex literary and informational texts independently and proficiently.

Writing (W)

- AS.W.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
- AS.W.2 Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
- AS.W.3 Write narratives to develop real or imagined experiences or events using effective technique, well- chosen details, and well-structured event sequences.
- AS.W.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- AS.W.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
- AS.W.6 Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
- AS.W.7 Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- AS.W.8 Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
- AS.W.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
- AS.W.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

Speaking and Listening (SL)

- AS.SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
- AS.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
- AS.SL.3 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.
- AS.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.
- AS.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.
- AS.SL.6 Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.

Language (L)

- AS.L.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
- AS.L.2 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.
- AS.L.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.
- AS.L.5 Demonstrate understanding of word relationships and nuances in word meanings.
- AS.L.6 Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Common Core State Standards for Mathematics

Quantities (Q)

- N.Q.1 Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- N.Q.2 Define appropriate quantities for the purpose of descriptive modeling.
- N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Seeing Structure in Expression (SSE)

- A.SSE.1 Interpret expressions that represent a quantity in terms of its context.

Creating Equations (CED)

- A.CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
- A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same

reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.

Reasoning with Equations and Inequalities (REI)

- A.REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
- A.REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
- A.REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

Linear, Quadratic, and Exponential Models (LE)

- F.LE.1.b Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

Modeling with Geometry (MG)

- G.MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

Interpreting Categorical and Quantitative Data (ID)

- S.ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).

Making Inferences and Justifying Conclusion (IC)

- S.IC.6 Evaluate reports based on data.

Using Probability to Make Decisions (MD)

- S.MD.5.a Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast- food restaurant.
- S.MD.6 (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).
- S.MD.7 (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

National Consortium for Health Science Education

Foundation Standard 1: Academic Foundation: Understand human anatomy, physiology, common diseases and disorders, and medical math principles.

- 1.1.1a Identify basic levels of organization of the human body
  - Chemical
  - Cellular
  - Tissue
  - Organs
  - Systems
  - Organism
- 1.1.1d Use directional terms
  - Anterior / Posterior
  - Medial / Lateral
  - Proximal / Distal

    - Superficial /Deep
    - Superior / Inferior
    - Ventral / Dorsal
- 1.1.1e Identify body cavities
    - Abdominal
    - Cranial
    - Dorsal
    - Pelvic
    - Spinal
    - Thoracic
- 1.1.2a Skeletal
    - Structures of the skeletal system
        - Distinguish between axial and appendicular skeletons
        - Describe long bone anatomy
        - Identify joint types and movement
        - Name and classify all bones (206)
    - Functions of the skeletal system
        - Structure and support
        - Muscle attachment and movement
        - Mineral storage
        - Hematopoiesis
- 1.1.2b Muscular
    - Structures of the muscular system
        - Identify types of muscle tissue
        - Identify major muscle groups of neck, shoulder, chest, abdomen, back, arms, and legs
    - Functions of the muscular system
        - Body movement
        - Posture
        - Protection
- 1.1.2c Integumentary
    - Structures of the integumentary system
        - Identify integumentary components
        - Label the layers of skin
    - Functions of the integumentary system
        - Vitamin D production
        - Sensory organ
        - Infection protection
        - Temperature regulation
        - UV light protection
- 1.1.2d Cardiovascular
    - Structures of the cardiovascular system
        - Identify cardiovascular organs
        - Label the parts of the heart
        - Distinguish blood components
    - Functions of the cardiovascular system

        - Blood flow through the heart and body
        - Transports nutrients, waste, antibodies, hormones, and gases
        - Cardiac conduction system
- 1.1.2e Lymphatic / Immune
    - Structures of the lymphatic system
        - Identify lymphatic organs
    - Functions of the lymphatic system
        - Provide protection against disease
        - Movement of lymph fluid
- 1.1.2f Respiratory
    - Structures of the respiratory system
        - Identify respiratory organs
    - Functions of the respiratory system
        - Gas exchange
- 1.1.2g Structures of the nervous system
        - Identify organs of the nervous system
        - Identify structures of the special sense organs
    - Functions of the nervous system
        - Sensation
        - Movement
        - Processing
- 1.1.2h Endocrine
    - Structures of the endocrine system
        - Identify endocrine glands
    - Functions of the endocrine system
        - Production of hormones
        - Regulation of body processes
        - Controls metabolism
        - Regulates growth, development, and maturation
- 1.1.2i Digestive
    - Structures of the digestive system
        - Identify digestive organs in sequence
        - Differentiate between alimentary and accessory organs
    - Functions of the digestive system
        - Chemical and mechanical digestion
        - Absorption of nutrients
        - Excretion of waste
- 1.1.2j Urinary
    - Structures of the urinary system
        - Identify urinary organs
        - Identify gross and microscopic anatomy of the kidney
    - Functions of the urinary system
        - Process of urine formation
        - Urine composition
        - Homeostatic balance
- 1.1.2k Reproductive

    - Structures of the reproductive system
        - Identify female reproductive organs
        - Identify male reproductive organs
    - Functions of the reproductive system
        - Formation of gametes
        - Production of hormones
- 1.2.1 Describe etiology, pathology, diagnosis, treatment, and prevention of common diseases and disorders, including, but not limited to the following:
    - Arthritis
    - Asthma
    - Cancer
    - Cataracts
    - Concussion / Traumatic Brain Injury (TBI)
    - Cystic fibrosis
    - Diabetes mellitus
    - Dementia
    - Gastric ulcer
    - Hepatitis
    - Hypertension
    - Melanoma
    - Muscular Dystrophy
    - Myocardial Infarction
    - Sexually Transmitted Infection (STI)
    - Stroke / Cardiovascular Accident (CVA)
    - Tuberculosis
    - Urinary Tract Infection (UTI)
- 1.2.2 Describe biomedical therapies as they relate to the prevention, pathology, and treatment of disease.
    - Gene testing
    - Gene therapy
    - Cloning
    - Stem cell research
- 1.3.1b Mathematical
    - Average
    - Ratios
    - Fractions
    - Percentages
    - Addition / Subtraction
    - Multiplication / Division
- 1.3.1c Conversions
    - Height (inches/meters)
    - Weight/mass (pounds/grams)
    - Length (inches/meters)
    - Volume (ml/cc)
    - Temperature (F/C)
    - Household measurements (Tbsp/tsp/cup/oz)

- 1.3.2 Demonstrate the ability to analyze diagrams, charts, graphs, and tables to interpret healthcare results.
- 1.3.3 Demonstrate use of the 24-hour clock/military time

Foundation Standard 2: Communications: Demonstrate methods of delivering and obtaining information, while communicating effectively.

- 2.1.1 Model verbal and nonverbal therapeutic communication.
  - Active listening
  - Silence
  - Summarizing
  - Reflecting
- 2.1.4 Interpret elements of communication using sender-message-receiver feedback model.
- 2.1.5 Modify communication to meet the needs of the patient/client and be appropriate to the situation.
- 2.1.6 Describe appropriate interactions with patients throughout various stages of psychosocial development.
- 2.2.1 Use common roots, prefixes, and suffixes to communicate information.
- 2.2.2 Interpret common medical abbreviations to communicate information.
- 2.3.1 Use proper elements of written and electronic communication (spelling, grammar, and formatting).
- 2.3.2 Prepare examples of technical and informative writing.

Foundation Standard 3: Systems: Identify how key systems affect services performed and quality of care.

- 3.1.1a Types of practice settings
  - Acute care
  - Ambulatory care
  - Behavioral and mental health services
  - Home care
  - Long-term care
  - Medical and dental practices
- 3.1.2 Examine the healthcare consumer's rights and responsibilities within the healthcare system.
  - Self-advocacy
  - Compliance
  - Patient's Bill of Rights

Foundation Standard 4: Employability Skills: Use employability skills to enhance employment opportunities and job satisfaction.

- 4.1.1 Identify personal traits and attitudes desirable in a career ready member of a health team.
  - Acceptance of criticism
  - Competence
  - Dependability
  - Discretion
  - Empathy
  - Enthusiasm
  - Honesty
  - Initiative

- Integrity
- Patience
- Positive Attitude
- Responsibility
- Self-motivation
- Tact
- Team player
- Willingness to learn

- 4.1.2 Summarize professional standards as they apply to hygiene, dress, language, confidentiality and behavior.
- 4.3.1 Research levels of education, credentialing requirements, and employment trends in health professions.
- 4.3.2 Distinguish differences among careers within a health science pathway.
  - Biotechnology research and development
  - Diagnostic services
  - Health informatics
  - Support services
  - Therapeutic services

Foundation Standard 5: Legal Responsibilities: Describe legal responsibilities, limitations, and implications on healthcare worker actions.

- 5.2.1 Apply standards for the safety, privacy and confidentiality of health information.
  - HIPAA
  - Privileged communication
- 5.2.3 Summarize the essential characteristics of a patient's basic rights within a healthcare setting.

Foundation Standard 6: Ethics: Understand accepted ethical practices with respect to cultural, social, and ethnic differences within the healthcare environment.

- 6.1.1 Differentiate between ethical and legal issues impacting healthcare.
- 6.1.2 Identify ethical issues and their implications related to healthcare.
  - Ethics committee
  - Euthanasia
  - In vitro fertilization
  - Organ donation
  - Scope of practice
- 6.2.2 Demonstrate respectful and empathetic treatment of ALL patients/clients.
  - Civility
  - Customer service
  - Patient satisfaction

Foundation Standard 7: Safety Practices: Identify existing and potential hazards to clients, co-workers, and self. Employ safe work practices and follow health and safety policies and procedures to prevent injury and illness.

- 7.1.1a Identify classifications of pathogens
  - Bacteria
  - Fungi
  - Parasites
  - Protozoa
  - Viruses
- 7.1.1b Describe characteristics of microorganisms

- Aerobic
- Anaerobic
- Non-pathogenic
- Pathogenic

- 7.1.1c Recognize chain of infection
- 7.1.1d Describe mode of transmission
  - Common vehicle (air, food, water)
  - Direct
  - Healthcare-associated infections (nosocomial)
  - Indirect
  - Opportunistic
  - Vectors
- 7.2.3a Asepsis
  - Sanitization
  - Antisepsis
  - Disinfection
  - Sterile technique
  - Sterilization
- 7.1.2b Standard precautions
  - Handwashing
  - Gloving
  - Personal Protective Equipment (PPE)
  - Environmental cleaning
- 7.1.2c Isolation precautions
  - Transmission-based contact
- 7.1.2d Bloodborne pathogen precautions
- 7.1.2e Vaccinations
- 7.2.3 Demonstrate and apply the use of personal protective equipment (PPE).
- 7.4.1 Observe all safety standards related to the occupational exposure to hazardous chemicals standard (safety data sheets [SDS]).
- 7.4.2 Comply with safety signs, symbols, and labels.

Foundation Standard 8: Teamwork: Identify roles and responsibilities of individual members as part of the healthcare team.

- 8.1.1 Evaluate roles and responsibilities of healthcare team members.
- 8.1.2 Identify characteristics of effective teams.
  - Defined roles
  - Common purpose
  - Effective communication
  - Effective leadership
  - Measurable processes and outcomes
  - Mutual respect
  - Shared goals
- 8.2.1 Recognize methods for building positive team relationships.
- 8.2.2a Characteristics
  - Focused and driven
  - Interpersonal skills
  - Motivates and inspires
  - Organized and balanced
- 8.2.2c Roles

- Communicates vision
- Leads change
- Manages accountability

- 8.2.4 Evaluate why teamwork is an important part of healthcare and how it improves patient care.

Foundation Standard 9: Health Maintenance Practices: Differentiate between wellness and disease. Promote disease prevention and model healthy behaviors.

- 9.1.1 Promote behaviors of health and wellness.
  - Exercise
  - Nutrition
  - Relationships
  - Sleep habits
  - Stress management
  - Weight control
- 9.1.2 Examine various aspects of behavioral health.
  - Anxiety
  - Depression
  - Substance abuse
  - Suicide
- 9.1.3 Describe strategies for prevention of disease.
  - Community health education outreach programs
  - Immunizations
  - Medical, dental, and mental health screenings
  - Routine physical exams
  - Stress management
- 9.2.1 Discuss physical, mental, social and behavioral development and its impact on healthcare.

Foundation Standard 10: Technical Skills: Apply and demonstrate technical skills and knowledge common to health career specialties.

- Demonstrate procedures for measuring and recording vital signs including the normal ranges.
  - Blood pressure
  - Temperature
  - Oxygen saturation
  - Pain
  - Pulse
  - Respirations

Foundation Standard 11: Information Technology in Healthcare: Apply information technology practices common across health professions.

- 11.1.1 Identify components of an electronic health record (EHR) and/or electronic medical record (EMR).
  - Diagnostic tests
  - History and physical
  - Medications
  - Patient demographics
  - Progress notes
  - Treatment Plan
- 11.1.2 Explore different types of health data collection tools.
  - Medical wearable devices

- Patient monitoring equipment
- Phone application
- Telemedicine/telehealth

- 11.1.3 Create electronic documentation that reflects timeliness, completeness, and accuracy.

Next Generation Science Standards (NGSS)

From Molecules to Organisms: Structures and Processes

- HS.LS1.1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
- HS.LS1.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- HS.LS1.3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- HS.LS1.4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
- HS.LS1.6 Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon- based molecules.

Ecosystems: Interactions, Energy, and Dynamics

- HS.LS2.5 Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
- HS.LS2.8 Evaluate the evidence for the role of group behavior on an individual's and species' chances to survive and reproduce.

Heredity: Inheritance and Variation of Traits

- HS.LS3.1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- HS.LS3.2 Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
- HS.LS3.3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Biological Evolution: Unity and Diversity

- HS.LS4.3 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

Earth and Human Activity

- HS.ESS3.4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Engineering Design

- HS.ETS1.1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS.ETS1.2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS.ETS1.3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

- HS.ETS1.4 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.

Matter and Its Interactions- Structure and Properties of Matter

- DCI - PS1.A Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- DCI - PS1.A 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)
- DCI - PS1.A 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)

Energy - Definitions of Energy

- DCI - PS3.A 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)
- DCI - PS3.A At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy . (HSPS3-2), (HS-PS3-3)

Energy - Conservation of Energy and Energy Transfer

- DCI - PS3.B 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)
- DCI - PS3.B The availability of energy limits that can occur in any system. (HS-PS3-1)
- DCI - PS3.B 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)

Engineering Design - Defining and Delimiting Engineering Problems

- DCI - ETS1.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)
- DCI - ETS1.A 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)
- DCI - ETS1.B 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)

Engineering Design - Optimizing the Design Solution

- DCI - ETS1.C 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)
- DCI - PS3.B The availability of energy limits that can occur in any system. (HS-PS3-1)

From Molecules to Organisms: Structures and Processes - Structure and Function

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

- DCI - LS1.A 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)
- DCI - LS1.A 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)
- DCI - LS1.B 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)
- DCI - LS1.C 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)
- DCI - LS1.C 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)
- DCI - LS1.C 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)

Ecosystems: Interactions, Energy, and Dynamics - Cycles of Matter and Energy Transfer in Ecosystems

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

Heredity: Inheritance and Variation of Traits - Inheritance of Traits

- DCI - LS3.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)
- DCI - LS3.B 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)

- DCI - LS3.B 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)

Biological Evolution: Unity and Diversity - Evidence of Common Ancestry and Diversity

- DCI - LS4.A Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)
- DCI - LS4.B 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)
- DCI - LS4.B The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)
- DCI - LS4.D Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7), (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)

Earth and Human Activity - Human Impacts on Earth Systems

- DCI - ESS3.C Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

Asking questions and defining problems

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

Developing and Using Models

Science and Engineering Practices	• 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 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	
Science and Engineering Practices	• 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	
Science and Engineering Practices	• 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. • 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. • Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. • 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. 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.
Using Mathematics and Computational Thinking	

Science and Engineering Practices	• 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. • 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/m^3, acre-feet, etc.)
Constructing Explanations and Designing Solutions	
Science and Engineering Practices	• 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.
Engaging in Argument from Evidence	
Science and Engineering Practices	• Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. • Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. • Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions. • Construct, use, and/or present an oral and written argument or counterarguments 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).
Obtaining, Evaluating, and Communicating Information	

Science and Engineering Practices	• 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).
Patterns	
Crosscutting Concepts	• 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. • Mathematical representations are needed to identify some patterns. • Empirical evidence is needed to identify patterns.
Cause and Effect: Mechanism and Prediction	
Crosscutting Concepts	• 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. • 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. • Systems can be designed to cause a desired effect. • Changes in systems may have various causes that may not have equal effects.
Scale, Proportion, and Quantity	
Crosscutting Concepts	• In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change. • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. • 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	
Crosscutting Concepts	• A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

	• Systems can be designed to do specific tasks. • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. • 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	
Crosscutting Concepts	• 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	
Crosscutting Concepts	• 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.

Key Vocabulary:			
absorption	chromosome	meiosis	codon
Adenosine tri-phosphate (ATP)	metabolism	Deoxyribonucleic Acid (DNA)	mitosis
allele	amino acid	antibody	aseptic technique
bacteria	calories	carbohydrate	cell
cellular respiration	cholesterol	electrophoresis	experiment
filtration	gene	heredity	homeostasis
hormone	immunity	infection	lipid
model	molecule	mutation	nucleotide
nutrient	organ	protein	restriction enzyme
Restriction Fragment Length Polymorphisms (RFLPs)	secretion	tissue	virus

Topics/Content Outline- Units and Themes:

Unit 1: Medical Investigation

- Lesson 1.1 Investigating the Scene
- Lesson 1.2 Master the Morgue

- Lesson 1.3 Open Investigation

Unit 2: Clinical Care

- Lesson 2.1 Talk to Your Doc
- Lesson 2.2 Decoding a Diagnosis
- Lesson 2.3 New to the Practice

Unit 3: Outbreaks & Emergencies

- Lesson 3.1 Nosocomial Nonsense
- Lesson 3.2 Emergency Response
- Lesson 3.3 Information Sharing

Unit 4: Innovation, Inc.

- Lesson 4.1 Designing the Future
- Lesson 4.2 New Frontier
- Lesson 4.3 Invitation to Innovation

Primary Resource(s):
Project Lead The Way Biomedical Science Program