PLANNED INSTRUCTION

A PLANNED COURSE FOR:
Biological Foundations

Curriculum Writing Committee:

Danielle Giordano, Rachael Lee, Emily Dowler

Grade Level: 9

Date of Board Approval: _____

Course Weighting: Biological Foundations

Major Assessments	45%
Skills Application	30%
Skills Practice	20%
Participation	5%
Total	100%

Curriculum Map

Overview: This two-teacher model course aligns to PA STEELS standards, with a focus on strengthening science practices and investigation of scientific phenomenon. This course will provide students with an overview of biological topics and skillsets that align with the Biology Keystone Exam, while also incorporating selected topics in environmental science and earth science. Content covered includes: the Nature of Science and Basic Biological Topics, including Structure and Function/Growth and Development of Organisms; Molecular Processes in Earth Systems; Matter and Energy; Ecosystem Interactions and Dynamics; Cell Structure, Function, and the Cell Cycle; DNA Structure and Replication. Each unit underscores the role of biology in the life of the student and will present relevance to present-day scientific issues. Students with diverse learning styles will have the opportunity to use a variety of learning methods to attain mastery of the skills and concepts necessary for success. These methodologies include direct instruction, laboratory activities and/or demonstrations, hands-on creative projects, interaction with various texts, collaboration with peers, guided inquiry, written assignments, and multimedia presentations.

Goals:

- **Marking Period 1 (45 days) -** Students will be able to review and apply…
    - **Unit 1: Nature of Science and Basic Biological Principles (45 days)**
        - Scientific methodology and experimentation
        - Characteristics of living things – unity of life
        - Organization of life – Atom → Molecule → Organelle → Cell → Tissue →Organ →Organ System →Organism/Species →Population → Community →Ecosystem →Biome →Biosphere
        - Classification of living things – kingdoms of life
        - The discovery of the cell and the cell theory
        - Structure, function, and comparison of prokaryotic and eukaryotic cells

        - Brief review of major eukaryotic cell organelles and functions
        - Cell transport and homeostasis, including passive and active transport

- **Marking Period 2 (45 days) -** Students will be able to review and apply…
    - **Unit 2: Molecular Processes in Earth Systems (C.3) (15 days)**
        - Basic atomic structure, molecules, and chemical bonds
        - Properties of water
        - Carbon compounds (carbohydrates, lipids, proteins, nucleic acids)
        - Introduction to nutrient cycling

    - **Unit 3: Ecosystem: Matter and Energy (B.2) (30 days)**
        - What is an ecosystem?
        - Flow of matter and energy within the Earth's spheres and ecosystems
        - Food chains and food webs
        - Carbon/nutrient cycling on a global scale due to increased fires
        - Ecological succession
        - Climate cycling
        - Solar energy distribution and effects
        - Energy Processes – photosynthesis, cellular respiration, decomposition
        - Positive feedback systems

- **Marking Period 3 (45 days) -** Students will be able to review and apply…
    - **Unit 4: Ecosystem Interactions and Dynamics (B.1) (25 days)**
        - Ecosystem interactions – human activities, migration, predation, herbivory, symbiosis, and competition
        - Density-independent and dependent limiting factors
        - Carrying capacity
        - Biodiversity
        - Endemic, Keystone, endangered, and invasive species
        - Conservationism and review of interacting systems

    - **Unit 5: Inheritance and Variation of Traits (B.3) (20 days)**
        - DNA structure, function, and replication
        - Cell division and mitosis – cell cycle, checkpoints and controls, cell types, mutations, and cancer
        - Cellular structure and function – types of cells, cancer cell morphology
        - Disease incidence – geographic location, genetic differences, social determinants of health
        - Cancer treatments
            - Extension: social determinants of health

- **Marking Period 4 (45 days) -** Students will be able to review and apply…
    - **Unit 5 (continued): Inheritance and Variation of Traits (B.3) (20 days)**
        - Meiosis, genetic variation (crossing over/independent assortment), and karyotyping/genetic testing

        - Central dogma of biology (gene expression/protein synthesis) – transcription and translation
        - Genetics terminology
        - Mendelian genetics, inheritance patterns, probability, exceptions to Mendel's Laws
        - Genetics of blood typing and pedigree analysis
        - Investigate interactions between genes and the environment (UV radiation)
        - Applied genetics: selective breeding, hybridization, inbreeding, and test crosses
        - Biotechnology and genetic engineering
            - Extension: ethical implications

    - **Unit 6: Diversity of Life, STEM and Laboratory Exploration, and Science Skill Enrichment (25 days)**
        - Enhance student understanding of the Animal, Plant, Protist, Fungal Kingdoms
        - Partake in various STEM activities including dissections, owl pellet lab, microscope use, working with dichotomous keys, etc.
        - Students will review and prepare for a final exam

Big Ideas:

- **Structure and Function:** Organisms have characteristic structures which enable functions and behaviors that allow them to grow, reproduce, and die.
- **Growth and Development of Organisms:** The characteristic structures, functions and behaviors of organisms change in predictable ways as they progress through their life cycle.
- **Organization for Matter and Energy Flow in Organisms:** The structures, functions, and behaviors of organisms allow them to obtain, use, transport, and remove the matter and energy needed to live.
- **Interdependent Relationships in Ecosystems:** Ecosystems are complex systems that include both living (biotic) and non-living (abiotic) components that interact with each other.
- **Cycles of Matter and Energy Transfer in Ecosystems:** The cycling of matter and the flow of energy within ecosystems occur through interactions among different organisms and between organisms and the physical environment.
- **Ecosystem Dynamics, Functioning, and Resilience:** As the environment and populations of species change, there are resulting changes in ecosystems.
- **Social Interactions and Group Behavior:** Many species live in groups, increasing the chances of survival for individuals and their relatives.
- **Inheritance of Traits:** Offspring resemble, but are not identical to, their parents due to traits being passed from one generation to the next via genes.
- **Variation of Traits:** Variation among individuals of the same species can be explained by both genetic and environmental factors.

- **Evidence of Common Ancestry and Diversity:** Comparisons between species provide evidence that they evolved from common ancestors, explaining the similarities and differences between species.
- **Natural Selection:** In any environment, individuals with particular traits may be more likely than others to survive and produce offspring.
- **Adaptation:** When the environment changes, some individuals in a population may have traits that provide a reproductive advantage which over many generations can change the makeup of a population.

Textbook and Supplemental Resources:

- **Primary Textbook Name:** *Inspire Biology*
    - **Textbook ISBN:** 978-0-07-688434-6
    - **Textbook Publisher/Year of Publication:** McGraw-Hill Education, 2020

- **Supplemental Resources:**
    - OpenSciEd Instructional Materials for Grades 9-12

Curriculum Plan

Unit 1: Nature of Science and Basic Biological Principles (45 Days)

- **Standards:**
  - **3.1.9-12.B** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
    - **Clarifying Statement:**
      - Emphasis is on functions at the organism system level, such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system. Assessment Boundary:
    - **Assessment Boundary:**
      - Assessment does not include interactions and functions at the molecular or chemical reaction levels.

  - **3.1.9-12.C** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
    - **Clarifying Statement:**
      - Emphasis is on functions at the organism system level, such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.
    - **Assessment Boundary:**
      - Assessment does not include interactions and functions at the molecular or chemical reaction levels.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• Developing and Using Models • Planning and Carrying out Investigations	• Structure and Function	• System and System Models • Stability and Change

- **Anchoring Phenomena:**
  - How do scientific experiments support or refute theories?
    - Example: Spontaneous Generation and Redi's Experiment, Discovery of Penicillin
  - *Are sea spiders different from spiders in your backyard?*

        - *Inspire Biology* (online Teacher Edition) →Browse the Course → Module 1: The Study of Life →Encounter the Phenomenon (right margin)
    - What makes Earth uniquely able to support life?
        - Example: Life on Earth – The Habitable Zone
    - How are living things classified?
        - Example: Microscopy Investigation of Kingdoms in a Pond

Objectives:

- State the goals of science and recall the steps of the scientific method (DOK 1)
- Conduct and/or analyze one or more scientific investigations (DOK 2 and DOK 4)
- Explain what a scientific theory is (DOK 3)
- Identify major themes in biology by describing the characteristics of living things and relating them to real-life examples (DOK 1)
- Identify patterns in the sequential organization of living things by recognizing examples in nature. (Atom →Molecule→Organelle→Cell→Tissue→Organ→Organ System) (DOK 2)
- Cite evidence of how structure relates to function (pertaining to molecules, cells, organs, etc.) (DOK 3)
- Describe the goals of binomial nomenclature and systematics (DOK 1)
- Name the six kingdoms of life as they are currently identified and explain what the tree of life represents (DOK 1)
- Differentiate between the variety of cells that exist in the 3 domains of life (DOK 3)
- Develop a logical argument that all organisms share common characteristics (DOK 3)
- State the three parts of the cell theory (All living things are made of cells; cells are the basic structure and function of living things; all cells come from pre-existing cells) and be able to apply each part to an example in nature (DOK 1, 4)
- Make connections of diversity and specialization of cells to real-life examples (DOK 4)
- Differentiate between the variety of cells that exist in the 3 domains of life (DOK 3)
- Compare and contrast prokaryotic and eukaryotic cells (DOK 2)
- List organelles found in eukaryotic cells (DOK 1)
- Classify structural features of eukaryotic cell organelle and relate the structural features with the organelle's function (DOK 2)
- Compare and contrast plant and animal cell organelle (DOK 2)
- Identify structure and function of components in the cell membrane (DOK 1)
- Distinguish between Active and Passive Transport (DOK 2)
- Apply knowledge of concentration gradients in order to explain the mechanisms by which materials move across the cell membrane (DOK 4)
- Recall the energy requirements that apply to different types of cell transport (DOK 1)

Core Activities and Corresponding Instructional Methods:

- State the goals of science and identify examples of observation, inference, hypothesis, principle, fact, scientific theory, and scientific law.
    - Present the students with a scientific investigation and engage prior knowledge about the topic.

    - Identify and define key vocabulary words pertaining to this content by way of a word sort, “click-n-drag,” matching activity, or the like.
    - (Optional) Read from Module 1 in the *Inspire Biology* textbook, Lesson 2, pages 11 - 16, which defines the nature of science, science methodology, careers in science, and factors that affect science and society. Expand on the reading by discussing the article on page 17 - “A Shot in the Arm.”
- Conduct and/or analyze one or more scientific investigations.
    - Complete a read-aloud, demonstration, or view a video that features a historical example of a scientific experiment (Example: Redi’s Investigation of Spontaneous Generation).
    - Complete a discussion and/or assessment pertaining to the experiments in order to recall the steps of the scientific method. In doing so, students will gain a deeper understanding of what science is and how certain scientific investigations have helped pave the way for current thinking in science.
    - Practice identifying the controlled, independent and dependent variables of the experiments - set up a controlled experiment if applicable.
    - Compare the historical examples to modern day scientific issues and practice creating hypothesizing solutions to everyday problems, with the understanding that each hypothesis should be able to be tested.
- Identify major themes in biology by describing the characteristics of living things and relating them to real-life examples.
    - Present students with a real-world phenomenon and guide students to create a driving question board that focuses on characteristics of life.
    - Provide authentic examples of characteristics of life and have students identify examples of the characteristics in nature.
    - (Optional) Read from Module 1 in the *Inspire Biology* textbook, Lesson 1, pages 4 - 10, to explore the field of biology and identify eight unifying characteristics of living things and to understand big ideas in biology.
- Identify the organization of living things and cite evidence of how structure relates to function.
    - Use real-world visual manipulatives to sort the organizational levels in the proper sequential order (Atom→Molecule→Organelle→Cell→Tissue→Organ→Organ System).
    - Provide students with random objects and have them provide an explanation for how the object’s structure relates to its function - use the same activity for biological examples such as organs in the human body, a tree’s tall branches reaching for sunlight, etc.
    - Perform, watch, or simulate an animal dissection to visualize the organization of multicellular organisms.
- Describe the present-day mechanisms for classifying organisms using binomial nomenclature and be able to distinguish between the three domains of life, as well as the six kingdoms of life.
    - Utilize examples and graphic organizers to review taxonomic levels (Example: Amoeba Sisters’s Classification).

    - Practice using a dichotomous key to practice identifying objects using a systematic process (Example Amoeba Sisters's Dichotomous Keys: Identification Achievement Unlocked).
    - Review characteristics utilized by taxonomists to classify species, including genetic code, physical features and behaviors, reproductive strategies, and habitats.
    - If reinforcement is required, research an organism to identify unique adaptations and related species based on classification criteria.
    - (Optional) Read from Module 16 in the *Inspire Biology* textbook, pages 424 - 445, to understand the history of taxonomy, the goals of binomial nomenclature first presented by Carolus Linnaeus, the modern classification system, domains and kingdoms of life, and the tree of life.
- Review scientific theory and review the three parts of the Cell Theory.
    - Hold a class discussion about the value of a scientific theory and how the Cell Theory is applied in biological study.
    - (Optional) Read from Module 7 in the *Inspire Biology* textbook, Lesson 1, pages 162-163, which discusses the discovery of the cell and the Cell Theory.
- Apply knowledge of the three Domains of Life (Archaea, Eubacteria, and Eukarya) to compare Prokaryotic and Eukaryotic Cells.
    - Create a Venn Diagram, graphic organizer, or other visual to compare and contrast Prokaryotic and Eukaryotic cells. This could become a classroom visual that can be added to throughout the year with additional learned details to distinguish these two major cell types.
    - Identify types of bacteria that share both positive and negative relationships with other organisms.
    - (Optional) Read from Module 7 in the *Inspire Biology* textbook, Lesson 1, pages 167-168, to identify the characteristics of prokaryotic and eukaryotic cells and review the kingdoms included in each domain.
- Utilize compound light microscopes to visualize cells.
    - Perform a lab to learn the features and functions of a light microscope and how to use appropriately.
    - View prepared slides and create wet-mount slides to view different types of cells (Example: Pond water analysis project)
- Review the structure and function of organelles in a eukaryotic cell.
    - Apply knowledge of organelles in the form of an analogy to a city, school, or another relatable topic.
    - Create a cut-n-paste/click-n-drag style model of a eukaryotic cell.
    - Perform research on a specific eukaryotic cell type and share findings with others to reinforce the diversity of cells.
    - Distinguish between the organelles in a plant and animal cell by analyzing images of each type. Compare these eukaryotic images to images of prokaryotic cells.
    - Read an article or watch a video on the Endosymbiotic Theory to create evolutionary connections to cell organelle structure.
    - (Optional) Read from Module 7 the *Inspire Biology* textbook, Lesson 4, pages 181-193, to identify the structure and function of eukaryotic cells.

- Investigate the structures and functions of the components of the cell membrane.
    - Draw, color, or label a picture that identifies components of the cell membrane and emphasize the importance of the cell membrane for cell transport and homeostasis.
    - (Optional) Read from Module 7 in the *Inspire Biology* textbook, Lesson 2, page 169-172, to identify the characteristics of the components of the cell membrane.
- Review types of cell transport as either passive or active and the manner in which materials are moving based on a concentration gradient.
    - Read from Module 7 in the *Inspire Biology* textbook, Lesson 3, pages 173-180, to compare and contrast Active and Passive Transport.
    - Perform diffusion and osmosis labs to demonstrate and measure cellular transport with eggs, dialysis tubing, or plastic bags.
    - View real-life examples of osmoregulation by viewing a story of a woman who drank too much water and died; and another woman who drank too much soy sauce.
    - Analyze images to distinguish major features of transport.

Correspondent Vocabulary:

- Scientific Method, Scientific Theory, Peer Review, Atom, Molecule, Organelle, Cell, Tissue, Organ, Organ System, Organism, Population, Community, Ecosystem, Biome, Biosphere, Homeostasis, Stimulus, Metabolism, Energy, Growth, Development, Asexual Reproduction, Sexual Reproduction, Adaptation, Evolution, Taxonomy, Kingdom, Phylum, Genus, Species, Binomial nomenclature, Eukaryotic, Prokaryotic, Nucleus, Deoxyribonucleic Acid (DNA), Cytoplasm, Mitochondria, Ribosomes, Endoplasmic Reticulum, Golgi Apparatus (Body), Lysosomes, Cytoskeleton, Centrosome (Centrioles), Cell Membrane, Concentration Gradient, Semi (selectively) permeable, Homeostasis, Passive Transport, Simple Diffusion, Facilitated Diffusion, Osmosis, Active Transport, Sodium-Potassium Pump, Adenosine Triphosphate (ATP)

Assessments:

- **Diagnostic:**
    - Teacher questioning and observation
    - Teacher-prepared questionnaire of prior knowledge
    - Vocabulary manipulatives
    - Warm-up activities
    - “See-Think-Wonder” Activity
    - Driving Question Board

- **Formative:**
    - Teacher questioning and observation
    - Group activities

- Independent worksheets
- Vocabulary/visual manipulatives
- Interactive digital manipulatives
- Laboratory Exercises
- Graphic Organizers
- Claim-Evidence-Reasoning or equivalent writing exercise
- Activities and Review Games - ex. *Quizizz or Kahoot*
- Google Slides "Click-n-Drags" (when applicable)
- Cell Models
- Exit Tickets
- Quizzes (as determined by the collective team)

- **Summative:**
  - Transfer Task(s)
  - Scientific Methodology Assessment (Multiple Choice/Free Response Questions)
  - Characteristics of Life and Taxonomy Assessment (Multiple Choice/Free Response Questions)
  - Microscopy and Prokaryotic Cells Assessment (Labeling/Multiple Choice/Free Response Questions)
  - Eukaryotic Cell Structure and Function Assessment (Labeling/Multiple Choice/Free Response Questions)
  - Cell Transport/Homeostasis Assessment (Labeling/Multiple Choice/Free Response Questions)

- **Correctives:**
  - Reread Chapter 1 in *Inspire Biology* and review the summary at the end of the chapter
  - Utilize the Keystone Biology Exam Review materials for this topic provided on Schoology
  - Give students supplemental vocabulary review materials
  - Give students web-based resources that reinforce the material presented in class
  - Give students extra practice identifying variables in an experiment
  - Give students extra practice identifying examples of levels of organization
  - Give students extra practice identifying examples of characteristics of life
  - Give students extra practice identifying examples of classification of life
  - Reteach and retest important concepts including essential vocabulary

- **Extensions:**
  - Case Studies - current event that pertains to an ecological issue
  - Guided Reading of Supplemental Resources
  - Interactive Activities on Websites

- Video Resources

Unit 2: Molecular Processes in Earth Systems (15 Days)

- **Standards:**
  - 3.1.9-12.F 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.
    - **Clarifying Statement:**
      - Emphasis is on using evidence from models and simulations to support explanations.
    - **Assessment Boundary:**
      - Assessment does not include the details of specific chemical reactions or identification of macromolecules.

  - 3.2.9-12.A Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
    - **Clarifying Statement:**
      - Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.
    - **Assessment Boundary:**
      - Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.

  - 3.2.9-12.C Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
    - **Clarifying Statement:**
      - Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.
    - **Assessment Boundary:**
      - Assessment is limited to chemical reactions involving main group elements and combustion reactions.

  - 3.3.9-12.K Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
    - **Clarifying Statement:**
      - Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a

stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).

- **Assessment Boundary:**
  - N/A

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• Developing and Using Models • Constructing Explanations and Designing Solutions • Planning and Carrying Out Investigations	• Structure and Properties of Matter • Chemical Reactions • Organization for Matter and Energy Flow in Organisms • The Roles of Water in Earth's Surface Processes	• Patterns • Energy and Matter • Structure and Function

- **Anchoring Phenomena:**
  - Patterns in the periodic table
    - Build an Atom - PhET Interactive Simulations
    - NOVA Elements
    - "Element Card" set
    - "Compond Representation" set
    - ChemThink Ionic Bonding Simulation
  - How can we live and what materials are required for life on other planets?
    - Meet the Artemis Team
    - "Space Missions Deck"
    - "Materials for Survival"
  - How does water support life and chemical reactions?
    - Open SciEd "Water Properties Investigation"
    - Gizmos "Sticky Molecules" Interactive Lab
    - OpenSciEd "Cleaning Metal-Contaminated Water"
    - OpenSciEd "Fertilizer from Urine:
  - Carbon and nutrient cycling
    - The Cycling of Carbon
    - Atmospheric Carbon Dioxide, Plants, and Phytoplankton
  - Body's needs for the important biomolecules of life
    - How to Read a Nutrition Label
    - Biomolecules on the Menu

Objectives:

- Identify and distinguish between the three subatomic particles found in atoms (DOK 1, 2)
- Describe the two main types of chemical bonds (DOK 2)
- Identify the parts of a chemical reaction, including reactants, products, appropriate symbols such as a "plus" sign and an "arrow" and the use of coefficients in front of chemical formulas (DOK 1)
- Identify patterns about the unique properties of water (DOK 2)
- Differentiate between solutions and suspensions (DOK 3)
- Compare acidic solutions and basic solutions (DOK 3)
- Relate the properties of carbon to its significance in many different structural and functional characteristics of living things (DOK 2)
- Introduce the carbon cycle to identify patterns in nutrient recycling (DOK 1)
- Differentiate between the structures and functions of each of the four groups of macromolecules (DOK 3)
- Apply concepts learned when studying proteins to the understanding of metabolic functions (enzymes) (DOK 4)

Core Activities and Corresponding Instructional Methods:

- Investigate major themes in selected chemistry units to focus on the chemistry of life inclusive of the major elements required for life, water, and macromolecules in C.3 Molecular Processes in Earth Systems in Open-SciEd.
- Identify and distinguish between the three subatomic particles found in atoms.
    - Observe and discuss necessary elements for life found in space, on Earth, and in the human body as outlined in C.3 Lesson 6 referencing types of atoms.
    - Complete a read-aloud activity, a discussion, watch a video, and/or create a model to display understanding of elements in the periodic table and their atomic structure using periodic tables, Element Data Cards in OpenSciEd C.3 Lesson 6, or periodic table templates.
    - Model electron configurations of common elements found in living organisms using tools from C.3 Lesson 7 like PhET build a model simulation (Build an Atom - PhET Interactive Simulations), Bohr model templates, atom construction kits, or similar.
- Describe the two main types of chemical bonds and analyze the role of valence electrons in bonding.
    - Evaluate and compare atomic structures models to display understanding of valence electrons and bonds between elements.
    - Create a model to display understanding of chemical bonding using Introduction to Ionic & Covalent Bonding - PhET Interactive Simulations , through magnetic atoms/whiteboards, or other manipulatives.
- Identify the parts of a chemical reaction, including reactants, products, appropriate symbols such as a "plus" sign and an "arrow" and the use of coefficients in front of chemical formulas by reading from Module 6 in the *Inspire Biology* textbook, Lesson 2, using interactive lessons "Explore and Explain" for chemical reactions and balanced chemical equations.

    - Practice identifying parts of chemical reactions using common examples in biology and completing the "Conservation of Energy Sketch Note".
    - Demonstrate balancing equations and the importance of the number of atoms being consistent on both sides of the equation using Balancing Chemical Equations - PhET Interactive Simulation or PBS Learning's Beyond the Elements Reactions Interactive.
- Identify patterns about the unique properties of water including its polar composition, hydrogen bonding, cohesion, adhesion, capillary action, high specific heat, and states of matter.
    - Complete Artemis activity using OpenSciEd C.3 Lesson 1 Space Mission Deck to brainstorm and create scale models of space exploration activities in preparation for substances needed for life.
    - Discuss substances needed to live on another planet using "Materials for Survival" tables.
    - Preview and brainstorm the Focus Question then read from Module 6 in the *Inspire Biology* textbook, Lesson 3, pages 144 - 147, to understand the properties of water. Supplemental videos, like PBS Learning's Crash Course Biology: Water - Liquid Awesome) or Amoeba Sisters's Properties of Water, may be used to reinforce learning.
    - Practice drawing or creating models of water molecules to exhibit its polar nature with molecule kits, magnetic atoms, or desktop paper models.
    - Use water molecule models to demonstrate hydrogen bonding for the 3 states of matter. Can be performed by having students "act out" water molecules or complete PBS Learning's interactive Water Simulation.
    - Identify the meaning of and examples of cohesion, adhesion, capillary action investigating through a lab activity "Water's Properties Investigations" from OpenSciEd C.3 Lesson 2, water drops on penny activity, or by completing "Polarity of Water Sketch Note" and/or "Water Sketch Note".
    - Discuss the importance of water and materials needed for living in space through OpenSciEd C.3 Lesson 10 "Cleaning Metal Contaminated Water"and C.3 Lesson 11 "Fertilizer from Urine".
- Differentiate between solutions and suspensions and compare acidic solutions and basic solutions.
    - Read from Module 6 in the *Inspire Biology* textbook, Lesson 3, pages 148 - 150, to understand mixtures with water, solutions, suspensions, solutes, solvents, acids, and bases.
    - Watch a video, perform a teacher demonstration, or have students complete a lab activity that exhibits different examples of solutions, suspensions, and testing for acids and bases using litmus paper or other indicators (Example: pH Scale - PhET Interactive Simulation).
    - Relate acidic and basic solutions to examples of homeostasis using PhET simulation Acid-Base Solutions or similar.
- Relate the properties of carbon to its significance in many different structural and functional characteristics of living things, particularly the four groups of macromolecules - carbohydrates, lipids, proteins, and nucleic acids.

- Observe the significance of carbon cycling in life's processes with PBS Learning's interactive The Cycling of Carbon simulation, Amoeba Sisters's Carbon and Nitrogen Cycles, or Carbon Cycle Sketch Notes.
- Practice identifying and drawing the carbon atom to understand how its valence electrons allow for versatility in creating life molecules including common macromolecule shapes.
- Create or fill in a graphic organizer, sketch notes, reader or reference cards that distinguish the structural and functional features that exist between and among carbohydrates, lipids, proteins, and nucleic acids.
- Create visible/tangible displays of macromolecules to reinforce the relationship between monomer and polymer which can include station learning, cooperative learning, and virtual activities.
- Perform a lab activity to identify macromolecules in an unknown substance using chemical properties (Examples: Murder/Stomach Contents Investigation Lab or HHMI's interactive Biomolecules on the Menu simulation)
- Explore the role of proteins as enzymes by performing a lab activity or watching a video. Read from Module 6 in the *Inspire Biology* textbook, Lesson 2, pages 140-142 to investigate the role of enzymes in chemical reactions and complete "Explore and Explain: Enzymes."
- Provide real-life examples of macromolecules such as in nutrition, everyday human body functions/composition, relevance in nature (Example: Oil harvested from whales, Chronic waste disease (CWD) in ungulates (refer to page 158 "Balancing your Plate" in textbook), or Carbon and Biological Molecules: What is LIfe Made Of? video.
- Complete review of carbon elements and their importance in game fashion (Examples: Chemistry in Biology Kahoot, desktop manipulatives, or LMS linked games (Kahoot, Quizizz, Blooket)).
- (Optional) Read from Module 6 in the *Inspire Biology* textbook, Lesson 4, pages 151 - 157, to define organic chemistry, understand how carbon's structure has titled it to be the "backbone of life" and the basis for biological molecules, and distinguishing between the 5 classes of macromolecules. Supplement with Amoeba Sisters's Biomolecules video.

Correspondent Vocabulary:

- Atom, Atomic Number, Atomic Mass, Chemical Reaction, Compound, Covalent Bond, Electron, Element, Energy Levels, Ion, Ionic Bond, Isotope, Matter, Mass, Molecule, Neutron, Nucleus, Orbital, Oxygen, Periodic Table, Proton, Valence Electron, Acid, Adhesion, Base, Buffer, Capillary Action, Cohesion, Hydrogen Bond, Mixture, Ph Scale, Polarity, Solute, Solution, Solvent, Surface Tension, Suspension, Specific Heat, Amino Acid, Antibody, Carbon, Carbohydrate, Catalyst, Deoxyribonucleic Acid, Energy, Enzyme, Fat, Genetics, Hydrogen, Lipid, Macromolecule, Monomer, Monosaccharide, Nitrogen, Nucleotide, Nucleic Acid, Oil, Oxygen, Phosphorus, Polymer, Polymerization, Polypeptide, Polysaccharide, Protein, Ribonucleic Acid, Steroid, Substrate

Assessments:

- **Diagnostic:**
  - Driving Question Board
  - Initial Models
  - Classroom Diagnostic Tools (CDT)
  - Teacher questioning and observation
  - Vocabulary manipulatives
  - Warm-up activities
  - Notice and Wonder Charts

- **Formative:**
  - Teacher questioning and observation
  - Group activities
  - Independent worksheets
  - Vocabulary/visual manipulatives
  - Interactive digital manipulatives
  - Laboratory Exercises
  - Graphic Organizers
  - Claim-Evidence-Reasoning or equivalent writing exercise
  - Activities and Review Games - Examples: *Quizizz or Kahoot*
  - Google Slides "Click-n-Drags" (when applicable)
  - Quizzes (as determined by the collective team)
  - Collected student work samples - Examples: Science Notebook or Models
  - Exit Tickets
  - Peer Feedback
  - Progress Trackers
  - Student self-assessment

- **Summative:**
  - Inorganic Chemistry Assessment (Consists of both Multiple Choice and Free Response Questions)
  - Properties of Water Assessment (Consists of both Multiple Choice and Free Response Questions)
  - Organic Chemistry Common Assessment (Consists of both Multiple Choice and Free Response Questions)
  - Transfer Task(s)

- **Correctives:**
  - Utilize the Keystone Biology Exam Review materials for this topic provided on Schoology
  - Give students supplemental vocabulary review materials
  - Give students web-based resources that reinforce the material presented in class
  - Give students extra practice identifying atoms, chemical bonds, valence electrons

    - Give students extra practice identifying the properties of water
    - Give students extra practice identifying the categories of macromolecules through sorting and matching activities
    - Reteach and retest important concepts including essential vocabulary

- **Extensions:**
    - Case Studies - current event that pertains to chemistry of life, the importance of water, nutrition and health related to macromolecules
    - Guided Reading of Supplemental Resources
    - Interactive Activities on Websites
    - Video Resources

Unit 3: Ecosystems: Matter and Energy (30 Days)

- **Standards:**
  - 3.1.9-12.E Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy
    - **Clarifying Statement:** Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.
    - **Assessment Boundary:** Assessment does not include specific biochemical steps.

  - 3.1.9-12.F 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.
    - **Clarifying Statement:**
      - Emphasis is on using evidence from models and simulations to support explanations.
    - **Assessment Boundary:**
      - Assessment does not include the details of specific chemical reactions or identification of macromolecules.

  - 3.1.9-12.G Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
    - **Clarifying Statement:** Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.
    - **Assessment Boundary:** Assessment should not include identification of the stops or specific processes involved in cellular respiration.

  - 3.1.9-12.H use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
    - **Clarifying Statement:** Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen, and nitrogen being conserved as they move through an ecosystem.
    - **Assessment Boundary:** Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.

  - 3.1.9-12.J Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions
    - **Clarifying Statement:** Emphasis is on the conceptual understanding of the role of aerobic and anaerobic respiration in different environments.

        - **Assessment Boundary:** Assessment does not include the specific processes of either aerobic or anaerobic respiration.

    - **3.1.9-12.K** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
        - **Clarifying Statement:** Examples of models could include simulations and mathematical models.
        - **Assessment Boundary:** Assessment does not include the specific chemical steps of photosynthesis and respiration.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• Developing and Using Models • Analyzing and Interpreting Data • Constructing Explanations and Designing Solutions • Using Mathematical and Computational Thinking	• Organization for Matter and Energy Flow in Organisms • Cycles of Matter and Energy Transfer in Ecosystems • Energy in Chemical Processes	• Energy and Matter • Systems and System Models

- **Anchoring Phenomena:**
    - How can the Delaware River support such a wide variety of life, and what happens when one part changes?
    - How do organisms in the Delaware River depend on each other for food and survival?
    - Fires are burning in the arctic and under ice and emerging in the spring to cause new fires.
        - Zombie fires more frequent in Boreal Forests
        - Blazes That Refuse to Die
        - Video: Zombie Fires Are on the Rise
        - Video: News report on increased zombie fires
        - Zombie fires in Alaska and Siberia
    - Carbon sinks around the world are burning due to human actions and putting lots of carbon dioxide into the atmosphere - causing a change in atmospheric temperature.
        - NASA visualization
        - NOAA History of Atmospheric Carbon Dioxide
    - How can prescribed burning, cultural burning, restoring grazer populations, and replanting forests help manage the amount of available carbon and energy that burn in wildfires (developing fire management systems)?
        - Karuk Fire Management (California)
        - Dja Dja Wurrung Clan and Forest Fire Management of Victoria

- Good Fire podcasts
- PBS The Age of Nature, Episode 3

Objectives:

- Define ecology and describe the methods used to study ecology (DOK 2)
- Explain how biotic and abiotic factors influence an ecosystem (DOK 3)
- Distinguish between the ecological levels of organization of living things (species→ population→community→ecosystem→biome→biosphere) (DOK 2)
- Define primary producers/autotrophs (DOK 1)
- Predict how the loss of primary producers will affect the ecosystem (DOK 2)
- Define consumers/heterotrophs (primary, secondary, tertiary) and identify patterns in which they obtain energy and nutrients (DOK 1 and DOK 2)
- Trace the flow of energy through living systems by using food chains, food webs, and energy pyramids (DOK 2)
- Identify cycles as patterns in nature and differentiate between the water cycle, carbon cycle, nitrogen cycle, and phosphorus cycle (DOK 2 and DOK 3)
- Compare types of succession such as those that occur after a natural disturbance and those that occur after a human caused disturbance (DOK3)
- Describe how ecosystems recover from a disturbance (DOK2)
- Identify the structure of ATP and explain its role in cellular work. (DOK2)
- Identify the "big picture" energy transformations that occur in both photosynthesis and cellular respiration (DOK 1)
- Recognize that both photosynthesis and cellular respiration are series of chemical reactions that take place inside organelles of cells and are affected by enzyme activity (DOK 1)
- Recognize that light and pigments are necessary components of photosynthesis (DOK 1)
- Identify the chemical equation for photosynthesis, including reactants and products (DOK 1)
- Identify and be able to draw the general structure of a chloroplast (DOK 1)
- Compare the different factors that affect the rate at which photosynthesis (DOK 3)
- Identify patterns by which organisms obtain energy needed for life processes (DOK 2)
- Identify the chemical equation for cellular respiration, including reactants and products (DOK 1)
- Identify and be able to draw the general structure of a mitochondrion (DOK 1)
- Compare and contrast aerobic and anaerobic respiration (DOK 2)
- Describe different types of anaerobic respiration (alcohol fermentation and lactic acid fermentation) (DOK 1)
- Analyze the difference in the amount of ATP that is generated by both anaerobic and aerobic respiration (DOK 4)
- Assess the relationship that exists in ecosystems between the processes of photosynthesis and cellular respiration (DOK 3)
- Identify which types of cells undergo photosynthesis and cell respiration (DOK 1)
- Apply prior understanding of autotrophs and heterotrophs to the processes of photosynthesis and cell respiration (DOK 4)
- Explain the effect of enzymes in speeding up chemical reactions and lowering activation

energy to catalyze reactions. (DOK 2)
- Connect prior knowledge of enzymatic reactions and how they affect chemical reactions (DOK 4)
- Apply concepts learned when studying biochemistry to the transformations that occur between molecules in photosynthesis and cellular respiration (DOK 4)
- Develop, use, and revise a model of the matter and energy flow in zombie fire systems so that they can apply this model to other carbon sinks and on a greater scale. (DOK3)
- Construct an explanation for how there was enough matter and energy in the peat/permafrost system for a zombie fire to burn under ice. (DOK 3)
- Plan and carry out investigations to identify changes in matter and energy under different conditions in the system. (DOK 3)
- Design a solution to balance matter and energy in a community students care about. (DOK 4)

Core Activities and Corresponding Instructional Methods:

- Investigate major themes of Unit B.2 in Open-SciEd to focus on matter and energy in ecosystems. Refer to Appendix B for Open-SciEd Unit B.2 flow chart.
- Investigate the question, "How can fires burn under ice and release so much energy and matter?
- Define ecology and identify biotic and abiotic factors that exist in the biosphere .
    - Students can identify biotic and abiotic factors in an ecosystem, through the use of their own drawings, teacher-provided photographs, videos, and more.
    - As per Open-Scied *B.2 Lesson 1 Slides - Arctic Fire Visual Inquiry*, students can identify factors in an ecosystem and the destruction of fire to a natural and designed system.
    - (Optional) Read from Module 2 in the *Inspire Biology* textbook, Lesson 1, pages 24 - 29, to define ecology, the biosphere, biotic and abiotic factors.
- Describe the levels of ecological study (Species/Organism, Population, Community, Ecosystem, Biome, Biosphere)
    - As per Unit B.2 in Open-SciEd, students should be able to apply knowledge of ecological organization to the Arctic ecosystem/biome.
    - Students can research a specific region or National Park to identify the levels of organization for the organisms and factors in the park.
    - (Optional) Read from Module 2 in the *Inspire Biology* textbook, Lesson 1, pages 30 - 31, to review ecological organization.
- Identify community interactions by defining competition, predation, and herbivory.
    - As per Unit B.2 in Open-SciEd, students should be able to apply knowledge of competition, predation, and herbivory to an Arctic ecosystem.
    - Students can research a specific region or National Park to identify competition, predation, and herbivory relationships in an ecosystem.
    - (Optional) Read from Module 2 in the *Inspire Biology* textbook, Lesson 1, pages 32 - 34, to learn about factors and relationships that shape communities and the patterns that exist in nature.

- Define primary producers (autotrophs) and consumers (heterotrophs) and the role that each type of organisms plays in an ecosystem, including the patterns that they exhibit to obtain energy and nutrients.
    - As per Unit B.2 in Open-SciEd, students should be able to apply knowledge of producers and consumers to an Arctic ecosystem.
    - Students can research a National Park to identify examples of producers, consumers (primary, secondary, and tertiary) as they would be displayed within a food web and also an energy pyramid for the park.
    - If time permits, dissect owl pellets for evidence of meal choice and sources of energy.
    - (Optional) Read from Module 2 in the *Inspire Biology* textbook, Lesson 2, pages 35 - 37, to review types of organisms as defined by the way in which they obtain their energy and the models that are used to display flow of energy in an ecosystem including food chains, food webs, and energy pyramids.
- When investigating the question, "What is peat and why does it burn so much?": Identify cycles as patterns in nature and differentiate between the water cycle, carbon cycle, nitrogen cycle, and phosphorus cycle.
    - Use a graphic to emphasize that energy exhibits a one-way pathway in ecosystems, while nutrients can be recycled.
    - Discuss a relatable example such as a scene from the *Lion King* titled "Mufasa's morning lesson with Simba," in which the King describes the way in which animals' bodies decompose into the soil and nutrients are recycled.
    - Look at images and models to investigate how temperature and oxygen levels affect decomposition rates.
    - Review the importance of biomolecules (Unit 2) such as carbohydrates, lipids, proteins, and nucleic acids, the elements (CHONP) that are necessary for their composition, and the sources for those elements in nature.
    - (Optional) Read from Module 2 in the *Inspire Biology* textbook, Lesson 3, pages 39 - 44, to define biogeochemical cycles and the manner in which nutrients cycle through an ecosystem.
- Compare types of succession such as those that occur after a natural disturbance and those that occur after a human caused disturbance and describe the ways in which ecosystems recover from such disturbances.
    - Watch a video and/or complete a video-based assignment on primary succession, such as one on the Mount Saint Helen volcano that erupted in the 1980s and the subsequent ecosystem recovery.
    - Have students provide written and/or visual drawings to predict and analyze ways in which succession events affect ecosystems including how zombie fires affect the Arctic ecosystem and local Delaware Water Gap ecosystems.
    - (Optional) Read from Module 3 in the *Inspire Biology* textbook, Lesson 1, pages 50 - 53, to learn about primary and secondary succession.
- Identify the "big picture" energy transformations that occur in both photosynthesis and cellular respiration and recognize that both processes are a series of chemical reactions that take place inside organelles of cells and are affected by enzyme activity.
    - Use a graphic organizer or visual to highlight the energy transformations that occur in ecosystems.

    - Identify types of energy - solar, chemical (glucose), and chemical (ATP) and the ways in which those forms are utilized by organisms.
    - (Optional) Read from Module 8 in the *Inspire Biology* textbook, Lesson 1, pages 198-201, to review the laws and label ATP structure.
- Recognize that light and pigments are necessary components of photosynthesis, be able to identify the reactants and products of photosynthesis and where the process occurs in plants, as well as the factors that affect the rate of photosynthesis.
    - Use a graphic organizer to allow students to better understand the overall process of photosynthesis—particularly the components that are needed for the reaction to work and the major products that result at the end of the process.
    - Show a video or animation of photosynthesis or have students sketch the reactions.
    - Use a word sort, "click-n-drag" or other manipulative that consists of chemical formulas and symbols that challenges students to correctly arrange the reactants and products for the photosynthesis chemical equation.
    - Investigate reasons for why there is an abundance of plant energy and matter in the peat in the zombie fire ecosystem.
    - (Optional) Read sections from Module 8 in the *Inspire Biology* textbook, Lesson 2, pages 202 - 204 to learn about the overall reactions of photosynthesis.
- Create a model and carry out an investigation (*Open-Scied B.2 Lesson 5*) to test whether changes in Earth's tilt has caused more available solar energy to plants and the effects that such an increase could have on stored energy and matter in peat and therefore, zombie fires.
    - Investigate how zombie fires disrupt the flow of energy and cycle of matter in Arctic Ecosystems.
    - Use case studies to investigate places, lands, and waters where global carbon sinks where global carbon sinks are burning with more frequency.
    - Analyze how matter and energy move through each system and discuss historical events and divisions that contributed to conditions that make carbon sinks more likely to burn.
    - Recognize the relationship between carbon sinks and photosynthesis.
    - Identify climate-related and human-caused factors that influence the burning of carbon
    - Make the connection that fire increases the flow of matter and energy from the biosphere to the atmosphere
- Identify the reactants and products of aerobic cellular respiration and where the process occurs in eukaryotic cells; compare and contrast aerobic and anaerobic respiration.
    - Use a graphic organizer to allow students to better understand the overall process of aerobic cellular respiration—particularly the components that are needed for the reaction to work and the major products that result at the end of the process.
    - Show a video or animation of aerobic cellular respiration or have students sketch the reactions.
    - Use a word sort, "click-n-drag" or other manipulative that consists of chemical formulas and symbols that challenges students to correctly arrange the reactants and products for the aerobic cellular respiration chemical equation.

    - Read about situations in which fermentation occurs in nature - (i.e., animals eating fermented berries or autobrewery syndrome).
    - (Optional) Read sections from Module 8 in the *Inspire Biology* textbook, Lesson 3, pages 213 - 214 to learn about anaerobic respiration.
    - (Optional) Read sections from Module 8in the *Inspire Biology* textbook, Lesson 3, pages 209 - 212 to learn about the overall reactions of aerobic cellular respiration.
- Look at images and/or develop models to investigate how temperature affects decomposition rate.
    - Carry out a demonstration, student investigation, or simulation that tests conditions such as temperature and oxygen levels on the rate of decomposition, and therefore cellular respiration. (B.2 Yeast Lab)
    - By analyzing the process of cellular respiration, students should see that energy from sugar is transferred to yeast and other decomposers and matter from sugar is transformed to grow more yeast and produce carbon dioxide and water.
    - Make comparisons about the differences in energy yield and yeast growth during aerobic respiration and anaerobic respiration.
    - Apply knowledge of temperature changes and oxygen levels to the permafrost/peat system and its slow rate of decomposition and cellular respiration.
- Create connections between physiological processes such as heart rate and breathing rate and energy demand and oxygen availability during cellular respiration and fermentation.
    - Watch David Blaine's "How I Held my Breath for 17 Minutes" to discuss the effects of Oxygen on energy availability and ways in which the body responds during a hypoxic situation.
- Perform a flower dissection to reinforce the structural organization of a plant

Correspondent Vocabulary:

- Species, Population, Community, Ecosystem, Biome, Biosphere, Zombie Fire, Fuel, Peat, Energy, Matter, Carbon Sink, Bioenergetics, Photosynthesis, Producer, Plants, Algae, Autotroph, Consumer, Heterotroph, Animals, Protozoa, Fungi, Primary And Secondary Succession, Glucose, Chemical Energy, Sunlight, Solar Energy, Oxygen, Carbon Dioxide, Water, Chloroplast, Stoma, Roots, Leaves, Cellular Respiration, Biomass, Mitochondria, Adenosine Triphosphate, Aerobic, Anaerobic, Decomposition, Fermentation, Ethanol, Lactic Acid, Carbon Cycle, Climate Change, Feedback System, Greenhouse Gases

Assessments:

- **Diagnostic:**
    - Teacher questioning and observation
    - Teacher-prepared questionnaire of prior knowledge
    - Vocabulary manipulatives
    - Warm-up activities
    - "See-Think-Wonder" Activity
    - Driving Question Board

- **Formative:**
    - Teacher questioning and observation
    - Group activities
    - Independent worksheets
    - Vocabulary/visual manipulatives
    - Interactive digital manipulatives
    - Laboratory Exercises
    - Graphic Organizers
    - Claim-Evidence-Reasoning or equivalent writing exercise
    - Activities and Review Games -Examples: *Quizizz or Kahoot*
    - Google Slides "Click-n-Drags" (when applicable)
    - Exit Tickets
    - Quizzes (as determined by the collective team)

- **Summative:**
    - Introductory Ecology Assessment (Multiple Choice/Free Response Questions)
    - Owl Pellet Lab
    - National Park Research Project
    - Bioenergetics Assessment (Multiple Choice/Free Response Questions)
    - Transfer Tasks

- **Correctives:**
    - Reread chapters in *Inspire Biology* and review the summary at the end of the reading
    - Utilize the Keystone Biology Exam Review materials for this topic provided on Schoology
    - Give students supplemental vocabulary review materials
    - Give students web-based resources that reinforce the material presented in class
    - Give students extra practice identifying ecological organization and
    - Give students extra practice identifying energy transfer in an ecosystem
    - Give students extra practice identifying key components of nutrient cycles
    - Give students extra practice comprehending the processes of photosynthesis and cellular respiration
    - Reteach and retest important concepts including essential vocabulary

- **Extensions:**
    - Case Studies - current event that pertains to an ecological issue
    - Introduce students to the types of communities that recover following succession events (pioneer, intermediate community, climax community)
    - Guided Reading of Supplemental Resources
    - Interactive Activities on Websites / Video Resources

Unit 4: Ecosystem Interactions and Dynamics (25 Days)

- **Standards:**
  - 3.1.9-12.H Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
    - **Clarifying Statement:**
      - Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen, and nitrogen being conserved as they move through an ecosystem.
    - **Assessment Boundaries:**
      - Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.

  - 3.1.9-12.I Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
    - **Clarifying Statement:**
      - Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.
    - **Assessment Boundaries:**
      - Assessment does not include deriving mathematical equations to make comparisons.

  - 3.1.9-12.L Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
    - **Clarifying Statement:**
      - Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.
    - **Assessment Boundaries:**
      - Assessment is limited to provided data.

  - 3.1.9-12.M Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
    - **Clarifying Statement:** Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate

hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.
        - **Assessment Boundaries:**
            - N/A

- 3.1.9-12.N Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
    - **Clarifying Statement:**
        - Examples of human activities can include urbanization, building dams, and dissemination of invasive species.
    - **Assessment Boundaries:**
        - Assessment does not include interactions and functions at the molecular or chemical reaction levels.

- 3.1.9-12.O Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
    - **Clarifying Statement:**
        - Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.
    - **Assessment Boundaries:**
        - N/A

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• Using Mathematics and Computational Thinking • Scientific Knowledge is Open to Revision in Light of New Evidence • Engaging in Argument From Evidence • Analyzing and Interpreting Data • Constructing Explanations and Designing Solutions	• Interdependent Relationships in Ecosystems • Ecosystem Dynamics, Functioning, and Resilience • Social Interactions and Group Behavior • Natural Selection • Adaptation	• Scale Proportion and Quantity • Stability and Change • Cause and Effect • Patterns • Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- **Anchoring Phenomena:**
    - "30 by 30" Initiative
    - The Great Migration of the Serengeti

        - Example reading: History of Serengeti National Park and Ngorongoro Conservation Area
        - Example video: From Serengeti to Maasai Mara: Survival on the Move (Wild Nature)
        - Example video: Bring them Home/Iniskim (PBS)
    - Wildebeest Population Trends Over Time
    - Predator–Prey Interactions
    - Biodiversity Stability in the Serengeti
    - Human Impacts & Conservation Decisions
    - Conservation Case Study: American Prairie Preserve

Objectives:

- Compare conservation strategies using success criteria, including biodiversity, stability, and stakeholder needs. (DOK 2)
- Identify characteristics used to describe a population. (DOK1)
- Identify and define limiting factors (food, space, human activities, migration, predation, herbivory, symbiosis, and competition) and their impact on population growth and carrying capacity in ecosystems. (DOK 1)
- Compare exponential growth and logistic growth. (DOK 2)
- Identify limiting factors that depend and do not depend on population density (DOK 1)
- Identify factors that determine carrying capacity (DOK 1)
- Organize and graph population and resource data to show trends in carrying capacity. (DOK 2)
- Construct explanations for changes in population size using mathematical evidence. (DOK 3)
- Predict future population changes in an ecosystem using models and justify predictions. (DOK 4)
- Describe how energy flows and matter cycles through an ecosystem (biomass and population relationships). (DOK 1)
- Analyze data from and revise models to explain how energy availability affects populations. (DOK 2)
- Evaluate human or natural disruptions on the flow of energy in an ecosystem and propose improvements. (DOK 4)
- Identify biodiversity and keystone species in ecosystems. (DOK 1)
- Assess the importance of endemic and endangered species to ecosystem stability. (DOK 3)
- Identify patterns of how invasive species impact biodiversity, habitats, and native species (DOK 3)
- Evaluate competing explanations of ecosystem change and defend the most supported claim. (DOK 4)
- Identify and interpret examples of individual and group behavior, such as herding and cooperative hunting. (DOK 1)
- Construct evidence-based arguments for how group behavior improves survival or reproduction. (DOK 3)
- Apply group behavior models to a new ecological system and argue whether the mechanism would change outcomes. (DOK 4)

- Identify human activities that affect ecosystems, such as roads and land use. (DOK 1)
- Construct and revise explanations for conservation success using stakeholder evidence and ecosystem models. (DOK 3)
- Design and defend a conservation plan for a new ecosystem with prioritized criteria and trade-offs. (DOK 4)

Core Activities and Corresponding Instructional Methods:

- Investigate major themes of Unit B.1 Ecosystem Interactions & Dynamics in Open-SciEd to focus on ecosystems interactions and dynamics. Refer to Appendix B for Open-SciEd Unit B.1 flow chart.
- Compare conservation strategies using success criteria, including biodiversity, stability, and stakeholder needs.
    - Driving Question Board, such as that outlined in the B.1 Ecosystem Interactions & Dynamics Lesson 1 Slides (centered around the 30 by 30 Initiative article set).
- Identify and define limiting factors in ecosystems and determine the dependence of each on population density and the need for or against conservation in such areas.
    - Have students create an ecosystem model, such as the initial model in B.1 Ecosystem Interactions & Dynamics Lesson 1 to compare various ecosystems' unique components and interactions and ways that they can be affected by human decision-making, while also looking at protected ecosystems as a means to provide insight for the protection of other systems in the future.
    - Have students create a consensus model in B.1 Ecosystem Interactions & Dynamics Lesson 2 to understand the reasons for conserving an ecosystem that is rich in biodiversity, such as the Serengeti.
    - Have students read the B.1 Ecosystem Interactions & Dynamics Lesson 2 article "A Brief History of the Serengeti" and "Serengeti Map" by administering a jigsaw activity, read aloud, etc.
    - Have students research a specific region or National Park to identify examples of community interactions that exist within the ecosystem.
    - As a means to practice data sorting and graphing, provide an opportunity to analyze limiting factors in an ecosystem, such as using the B.1 Ecosystem Interactions & Dynamics Lesson 3 "Wildebeest Data Cards" and/or scientist interview activities.
    - Perform a rainfall and resource mapping analysis, such as the activity in B.1 Ecosystem Interactions & Dynamics Lesson 4.
    - Research a region or National Park to identify examples of density-independent and dependent factors that exist within the park.
    - Explain the historical and future patterns that age structure diagrams can display about populations, using an activity such as the "Power of the Pyramids."
    - (Optional) Read from Module 2 in the *Inspire Biology* textbook, Lesson 1, pages 32 - 34, to learn about factors and relationships that shape communities and the patterns that exist in nature.
- Use representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
    - Construct a logistic growth curve to label and explain the phases of exponential and logistic growth and predict carrying capacity.

    - Analyze survivorship curves for real-world applications and discuss evolutionary strategies for maximizing survivorship.
    - Construct mathematical expressions to distinguish the factors that influence a population's growth rate (natality (birth rate), mortality, immigration, emigration).
    - Perform a carrying capacity simulation, such as the B.1 Ecosystem Interactions & Dynamics Lesson 5 "Serengeti Kinesthetic Model", to create a mathematical representation and/or make sense of patterns.
    - (Optional) Read from Module 4 in the *Inspire Biology* textbook, Lesson 1 and 2, pages 77 - 93 to learn about population growth curves, limiting factors, and demography.
- Determine that group behaviors increase survival for predators and prey.
    - Play a predator–prey simulation game, such as the B.1 Ecosystem Interactions & Dynamics Lesson 7 "Serengeti Board Game" or the "Predator vs. Prey" from the Smithsonian Learning Lab.
    - Practice data collection and analysis through prompts and handouts, supporting the predator-prey simulation game.
- Assess the importance of biodiversity (keystone species, endemic species, endangered species, invasive species) to ecosystem stability.
    - Model biodiversity by using the B.1 Ecosystem Interactions & Dynamics Lesson 8 "Serengeti Component Articles" and SageModeler template with disturbance testing or other equivalent manipulations.
    - Evaluate competing explanations of ecosystem change and defend the most supported claim through studying the effects of climate change on polar bear populations.
- Identify human activities that affect ecosystems and evaluate conservation plans.
    - Evaluate evidence of human–ecosystem interactions, such as wildlife corridor data, such as live cam footage, the B.1 Ecosystem Interactions & Dynamics Lesson 9 "Interest Holder Cards", video evidence, and "Road Proposal Cards" (via an organizer).
    - Evaluate conservation success, such as using the B.1 Ecosystem Interactions & Dynamics Lesson 1 Conservation Profiles and B.1 Ecosystem Interactions & Dynamics Lesson 9 and 10 evaluation handouts.
    - Group performance-based assessment, such as the B.1 Ecosystem Interactions & Dynamics Lesson 10 "Group Impact Map" or an informative art piece on the Pennsylvania Game Commission's list of threatened and endangered species.
    - (Optional) Read from Module 5 in the *Inspire Biology* textbook, Lessons 1-3, pages 98 - 113, to learn about biodiversity, threats and actions for remediation.
- Design and defend a conservation plan for a new ecosystem with prioritized criteria and trade-offs.
    - Create a "Species Survival Plan" for a species on the Pennsylvania Game Commission's list of threatened and endangered species.
    - Create a final consensus ecosystem model using the "Driving Question Board" review protocol from B.1 Ecosystem Interactions & Dynamics Lesson 10 or otherwise equivalent "Driving Question Board" procedure.

Correspondent Vocabulary:

- Conservation, Conservation plan, Criteria, Constraints, Interest holder, Land use, Protected area, 30x30 Initiative, Trade-offs, Biodiversity, Keystone species, Endemic species, Endangered species, Invasive species, Ecosystem, Habitat, Resource availability, Stability, Resilience, Disturbance, System interactions, System model, Carrying capacity, Limiting factor, Density-independent limiting factor, Density-dependent limiting factor, Predation, Herbivore, Symbiosis, Competition, Migration, Population size, Mortality factors, Growth rate, Biomass, Group behavior, Herding, Cooperative hunting, Survival rate, Predator–prey interactions, Risk reduction, Survival advantage, Energy flow, Trophic level, Food source, Matter cycling, Resource cycling, Conservation of matter and energy, Algorithm, Computational simulation, Empirical evidence, Data representation, Mathematical representation, Rate of change, Trend analysis, Prediction, Natural resource management, Sustainability, Ecosystem services, Human impact, Evaluation, Analyze, Evaluate, Revise, Optimize, Criteria-based decision making, Claim-Evidence-Reasoning (CER)

Assessments:

- **Diagnostic:**
  - Classroom Diagnostic Tools (CDT)
  - Teacher questioning and observation
  - Vocabulary manipulatives
  - Warm-up activities
  - Notice and Wonder Charts
  - Driving Question Board
  - Initial Models

- **Formative:**
  - Teacher questioning and observation
  - Group activities
  - Performance-based assessments
  - Independent worksheets
  - Vocabulary/visual manipulatives
  - Interactive digital manipulatives
  - Laboratory Exercises
  - Graphic Organizers
  - Activities and Review Games - Examples: *Quizizz or Kahoot*
  - Quizzes (as determined by the collective team)
  - Claim-Evidence-Reasoning or equivalent writing exercise
  - Collected student work samples - Examples: Science Notebook or Models
  - Exit Tickets
  - Peer Feedback
  - Progress Trackers
  - Student self-assessment

- **Summative:**
  - Transfer Task(s)
    - Transfer task on limiting factors and carrying capacity using the B.1 Ecosystem Interactions & Dynamics Lesson 6 “African Wild Dog Transfer Task” with embedded peer feedback and revision.
    - Transfer task to design, evaluate, and refine a solution for reducing human impacts on biodiversity, such as the B.1 Ecosystem Interactions & Dynamics Lesson 11 “American Prairie Task”.
  - Ecosystem Interactions and Dynamics Assessment

- **Correctives:**
  - Give students supplemental vocabulary review materials
  - Give students web-based resources that reinforce the material presented in class
  - Give students extra practice identifying data table and graphical trends
  - Give students extra practice identifying examples of density-independent and dependent limiting factors
  - Give students extra practice identifying conservation criteria and with decision-making
  - Keystone-Style Data Interpretation Activities using teacher-created question sets aligned to STEELS standards and Lesson 3–8 data
  - Reteach and retest important concepts including essential vocabulary

- **Extensions:**
  - Create an educational video explaining the Serengeti as a complex system
  - Find a compelling connection between the Serengeti and one of Pennsylvania’s State Parks or Forests
  - Compare/contrast wildebeest migration with Arctic caribou, Monarch butterflies, and/or Salmon spawning
  - Case Studies - current event that pertains to an ecological issue
  - Guided Reading of Supplemental Resources
  - Interactive Activities on Websites
  - Video Resources

Unit 5: Inheritance and Variation of Traits (40 Days)

- **Standards:**
  - 3.1.9-12.A 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.
    - **Clarifying Statement:**
      - N/A
    - **Assessment Boundaries:**
      - Assessment does not include the identification of specific cell or tissue types of body systems, specific protein structures and functions, or the biochemistry of protein synthesis.

  - 3.1.9-12.B Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
    - **Clarifying Statement:**
      - Emphasis is on functions at the organism system level, such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system. Assessment Boundary:
    - **Assessment Boundary:**
      - Assessment does not include interactions and functions at the molecular or chemical reaction levels.

  - 3.1.9-12.D Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
    - **Clarifying Statement:**
      - N/A
    - **Assessment Boundary:**
      - Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.

  - 3.1.9-12.P Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
    - **Clarifying Statement:**
      - N/A
    - **Assessment Boundary:**
      - Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.

  - 3.1.9-12.Q 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.
    - **Clarifying Statement:**
        - Emphasis is on using data to support arguments for the way variation occurs.
    - **Assessment Boundary:**
        - Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.

- 3.1.9-12.R Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
    - **Clarifying Statement:**
        - Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.
    - **Assessment Boundary:**
        - Assessment does not include Hardy-Weinberg calculations.

- 3.5.9-12.I 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.
    - **Clarifying Statement:**
        - 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.
    - **Assessment Boundary:**
        - N/A

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• Constructing Explanations and Designing Solutions • Developing and Using Models • Asking Questions and Defining Problems • Engaging in Argument From Evidence • Analyzing and Interpreting Data	• Structure and Function • Developing Possible Solutions • Growth and Development of Organisms • Inheritance of Traits • Variation of Traits	• Structure and Function • Systems and System Models • Cause and Effect • Scale Proportion and Quantity • Science is a Human Endeavor

- **Anchoring Phenomena:**
    - Cancer Data
        - Example: US Cancer Graphics by Incidence, Mortality, and Geographic Location
    - Genetic Engineering
        - Example: National Geographic article on Genetic Technology
        - Example: nature video on CRISPR technology
    - Selective Breeding
        - Example: *National Geographic* documentary "Science of Dogs"

Objectives:

- Describe the structure of DNA and explain how genetic information is stored in cells. (DOK 1)
- Recall that nucleotides are the molecular subunits of DNA discussed in Unit 2 (DOK 1)
- Identify the relationship between DNA, genes, and chromosomes. (DOK 1)
- Describe the process of DNA replication and its role in cell division. (DOK 2)
- Identify DNA replication as a repeating pattern that occurs prior to cell division and throughout an organism's lifetime (DOK 2)
- Summarize the stages of the cell cycle (DOK 2)
- Identify what happens to chromosomes during the four phases of mitosis (DOK 1)
- Define cytokinesis and distinguish difference in cytokinesis in animal cells and plant cells (DOK 2)
- Explain how cells regulate the cell cycle and maintain normal growth. (DOK 2)
- Distinguish between cancer cells and healthy cells (DOK 2)
- Relate the onset of cancer to the control of the cell cycle (DOK 2)
- Obtain, evaluate, and communicate information about cancer treatment options, including how to use health navigators to prevent and treat cancer. (DOK 3)
- Recall and differentiate between asexual and sexual reproduction (DOK 3)
- Differentiate between somatic (body) cells as having a diploid number of chromosomes and gametes (sex cells) as having a haploid number of chromosomes (DOK 3)
- Summarize the events of meiosis and compare and contrast meiosis and mitosis (DOK 3)
- Analyze and/or create a karyotype in order to recognize chromosomal defects that may occur during meiosis as a result of nondisjunction(DOK 4)
- Distinguish the effects of nondisjunction during mitosis vs. meiosis
- Describe how genes in DNA code for proteins and how proteins influence observable traits through gene expression. (DOK 2)
- Compare and contrast the structure of DNA to that of RNA (DOK 2)
- List the 3 types of RNA (DOK 1)
- Explain why DNA must make mRNA in order to successfully produce proteins (DOK 1)
- Summarize the process of transcription, including the enzymatic activity (DOK 2)
- Recall that amino acids are the subunits of proteins (DOK 1)
- Make connections to show how mRNA codons, that were transcribed from a DNA blueprint, are then translated into a code of amino acids (DOK 4)
- Summarize the process of protein synthesis (translation), including the role of DNA, mRNA, tRNA, and rRNA (DOK 2)

- Identify different types of mutations and explain how they alter DNA sequences. (DOK 2)
- Analyze how mutations can change protein structure and affect cell function. (DOK 3)
- Evaluate evidence for how environmental factors influence mutation rates and trait variation. (DOK 4)
- Develop and revise models explaining how inherited and acquired mutations alter cell behavior and contribute to cancer development. (DOK 3)
- 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. (DOK 4)
- Describe geneticist Gregor Mendel's studies and conclusions about inheritance and how Mendel's principles apply to all organisms (DOK 1)
- Explain the difference between Mendelian and non-Mendelian genetics (such as codominance, incomplete dominance, and sex-linked traits). (DOK 3)
- Analyze patterns of inheritance using pedigrees and probability models. (DOK 3)
- Use mathematical reasoning (Punnett Squares) to predict the likelihood of inheriting specific traits or mutations. (DOK 3)
- Identify examples of applied genetics such as selective breeding, hybridization, inbreeding, and test crosses. (DOK 1)
- Identify and connect examples of biotechnology, genetic engineering, gene splicing to the students' understanding of the principles of DNA and how it can be applied to techniques for gene therapy and genetically modified organisms. (DOK 4)
- Evaluate the effects of new biotechnologies on society, including ethical implications. (DOK 4)

Core Activities and Corresponding Instructional Methods:

- Investigate major themes of Unit B.3 Inheritance and Variation of Traits in Open-SciEd to focus on heredity. Refer to Appendix B for Open-Scied Unit B.3 flowchart.
- Describe the structure of DNA, genes, and chromosomes and explain how genetic information is stored in cells.
    - Present vocabulary and concepts in a way that students can use as a study tool and mastery of the main ideas and terminology.
    - Supplement with Amoeba Sisters's video on Alleles and Genes and corresponding "Video Recap" worksheet.
    - Investigate the structure of DNA using diagrams and molecular models, such as the Computer Simulation in Unit B.3 Inheritance and Variation of Trait Lesson 5, to identify nucleotides, base pairing, and double helix structure.
    - Create, draw, or color a model of the DNA double helix.
    - Watch a guided video featuring DNA structure and function such as PBS NOVA's "DNA: The Secret of Life."
    - Perform a DNA extraction from a chosen source such as their cheek cells, strawberries, bananas, spinach, etc.

    - (Optional) Read from Module 11 in the *Inspire Biology* textbook, Lesson 1, pages 291 - 295, to review the structure of the DNA double helix, and the scientific collaboration that led to its discovery.
- Describe the process of DNA replication and its role in cell division.
    - Read from Module 11 in the *Inspire Biology* textbook, Lesson 2, pages 296 - 298, to understand the process of DNA replication, including its necessity for cell division, the role that enzymes play in the process.
    - Watch an animation featuring DNA replication.
    - Use a simulation, hands-on manipulative, or cut-n-paste type of activity to allow students to practice base-pairing for DNA replication.
    - Investigate DNA replication using diagrams and molecular models, such as the Computer Simulation in Unit B.3 Inheritance and Variation of Trait Lesson 5.
- Summarize the stages of the cell cycle, including interphase, mitotic division and cytokinesis (and the differences between animal and plant cells), and recognize that DNA must be copied before cell division can occur.
    - Draw, sort, or use an interactive simulation, such as the "Cell Game" in Unit B.3 Inheritance and Variation of Trait Lesson 4, to understand the events that take place in mitosis and cytokinesis.
    - Complete Cell Cycle/Mitosis Stations – various visuals and sorting activities that challenge students to practice and hopefully reach mastery of understanding the topics presented. Stations include sorting pictures; matching vocabulary cards with descriptions; sequencing different style of models (both purchased and teacher generated); coloring large poster-size "reasons cells divide" pictures; completing a large poster-size crossword puzzle with dry-erase markings (enhances "buy-in" from the students); teacher- generated ***Google Slides*** interactive "click and drag" as well as a traditional "cut-n-paste" to correctly identify and sequence the stages of the cell cycle.
    - Watch educational videos or animations that highlight the events that occur in the cell cycle - interphase, mitosis, and cytokinesis.
    - For enrichment, have students create a model for mitosis (Examples: Sugar cookie or Oreo lab).
    - (Optional) Read from Module 9 in the *Inspire Biology* textbook, Lesson 1, pages 223 - 227, to learn about the stages of the cell cycle, including the 3 important events that occur in Interphase - growth, DNA synthesis, and preparation for division.
- Explain how cells regulate the cell cycle and maintain normal growth.
    - Complete the Nobel Prize "Cell Cycle Control" game or "Cell Game" in Unit B.3 Inheritance and Variation of Trait Lesson 4 to review the three checkpoints in the cell cycle.
    - (Optional) Read from Module 9 in the *Inspire Biology* textbook, Lesson 1, pages 228 - 230, to learn about cell cycle regulation, apoptosis, and patterns in abnormal cell cycle regulation that leads to cancer.
- Obtain, evaluate, and communicate information about current cancer treatment options and propose solutions about how to use health navigators within the healthcare system in cancer prevention and treatment.

    - Understand that cancer cells develop as a result of a disruption to the cell cycle due to a mutation in DNA - read an article about the types, causes, and treatments of cancer.
    - Explore how different cancer treatments work and how the constraints of treatment predict treatment outcomes for cancer cells by using the Unit B.3 Inheritance and Variation of Trait Lesson 11 "Cell Game".
    - Learn about how social determinants of health affect treatment and solutions, through analyzing cancer data, calculating survival rates, reading articles, and developing interview protocols using Unit B.3 Inheritance and Variation of Trait Lesson 12 resources or equivalencies.
- Recall the differences between asexual and sexual reproduction as a lead into a discussion of the events that occur in meiosis and the production of gametes (sex cells). Distinguish between diploid body cells and haploid gametes and identify similarities and differences between the processes of mitosis and meiosis.
    - Draw, sort, or use an interactive simulation to understand the events that take place in meiosis.
    - Watch educational videos or animations that highlight the events that occur in meiosis.
    - Complete a graphic organizer such as a Venn diagram that compares and contrasts mitosis and meiosis.
    - (Optional) Read from Module 9 in the *Inspire Biology* textbook, Lesson 2, pages 231 -238 , to learn about meiosis, chromosomes, mitosis vs. meiosis, and sexual vs. axesual reproduction.
- Explain what a karyotype is and why it is used and practice creating and/or analyzing a karyotype in order to recognize chromosomal defects that may occur during meiosis as a result of nondisjunction.
    - Practice creating a karyotype by either cutting out a picture of chromosomes and rearranging them, use a preset template, or complete the activity using a computerized simulation.
    - (Optional) Read from Module 9 in the *Inspire Biology* textbook, Lesson 2, pages 239 -241, to learn about karyotyping and nondisjunction, autosomes vs. sex chromosomes and examples of genetic conditions that result from chromosomal abnormalities.
- Describe how genes code for sequences of amino acids that join together to form proteins and how these proteins influence observable traits through gene expression.
    - Read from Module 11 in the *Inspire Biology* textbook, Lesson 3, pages 299 - 303, to understand the process of DNA transcription and translation, including the role of the three types of mRNA and enzymes in the production of proteins.
    - Create an analogy for the students about the roles of DNA, mRNA, rRNA, tRNA and the production of proteins (DNA = Captain of ship; mRNA = first mate; rRNA = the ship deck; tRNA = the crew members doing the heavy lifting) or have the students create their own analogy for protein synthesis.
    - Use a classroom model, video, or manipulative to allow students to visualize/demonstrate protein synthesis.

    - Participate in a kinesthetic model, such as the classroom cell model in Unit B.3 Inheritance and Variation of Trait Lesson 6, to see how different versions of proteins have different functions.
    - Read an article about gene expression, like "DNA and p53" in Unit B.3 Inheritance and Variation of Trait Lesson 6, to obtain additional information.
- Identify different types of mutations and explain how they alter DNA sequences, protein structure, and affect cell function.
    - Demonstrate the effects of DNA mutations in protein synthesis examples.
    - Practice scenarios in which mutations can occur and discuss the differences in outcomes for mutations occurring during DNA replication prior to mitosis and those that occur prior to meiosis.
    - Refer to the chart on page 311 in *Inspire Biology* to identify types of mutations and examples of associated diseases.
    - For enrichment, complete a genetic disorder project that distinguishes between those that are the result of DNA mutations versus those that are the result of chromosomal abnormalities.
    - (Optional) Read from Module 11 in the *Inspire Biology* textbook, Lesson 4, pages 306 - 314 to learn about gene regulations and mutations.
- Apply concepts about DNA and meiosis to the understanding of heredity as explained through Grengor Mendel's genetic studies.
    - Present vocabulary and concepts in a way that students can use as a study tool and mastery of the main ideas and terminology.
    - Watch the Amoeba Sisters's Mendelian Inheritance Video and complete the corresponding Video Recap Worksheet
    - (Optional) Read from Module 10 in the *Inspire Biology* textbook, Lesson 1, pages 252 - 254, to learn about knowledge of essential vocabulary terms including genetics, allele, dominant, recessive, homozygous, heterozygous, phenotype, and genotype.
    - (Optional) Read from Module 10 in the *Inspire Biology* textbook, Lesson 1, pages 255 - 256, to understand Mendel's laws of segregation and independent assortment.
- Practice the principles of probability to predict genetic crosses by setting up and analyzing Punnett Squares to predict the likelihood of inheriting specific traits or mutations.
    - Practice numerous examples of interpreting genotypes and phenotypes of organisms, setting up, and solving Punnett squares to be able to find the probability of traits being passed from one generation to the next.
    - (Optional) Read from Module 10 in the *Inspire Biology* textbook, Lesson 1, pages 257 - 259, to learn about Punnett Squares, monohybrid and dihybrid crosses and the probability of genes being passed from one generation to the next through fertilization.
- Analyze patterns of inheritance using pedigrees and probability models.
    - Using the Unit B.3 Inheritance and Variation of Trait Lesson 8 resources or equivalencies, watch videos about disease incidence and model familial inheritance using a pedigree.

    - (Optional) Read from Module 10 in the *Inspire Biology* textbook, Lesson 4, pages 266 - 272, to understand how pedigree analysis can be used to predict or analyze inheritance patterns of traits among families.
- Evaluate evidence for how environmental factors influence mutation rates and trait variation.
    - Investigate how the environment might explain cancer not accounted for by random and germline mutation, by analyzing scientific data related to the incidence of skin cancer and/or collecting yeast data in Unit B.3 Inheritance and Variation of Trait Lesson 9 or via equivalent investigations.
    - Read and/or watch a video about the mechanism of UV radiation causing mutations in our cells and about a protective mechanism in our skin, using a resource like the *Skin Cancer Background Reading* in Unit B.3 Inheritance and Variation of Trait Lesson 9 or the NOVA Gross Science video on *What Really Causes Sunburns?*
- Develop and revise models explaining how inherited and acquired mutations alter cell behavior and contribute to cancer development.
    - Develop initial models after reviewing cancer data, using strategies outlined in Unit B.3 Inheritance and Variation of Traits Lessons 1 and 2, like an Initial Ideas Discussion, Driving Question Board, Exit Ticket, Notice/Wonder Chart, Peer Feedback, and Progress Tracker.
    - Develop a consensus model that puts together all of the ideas about random mutations, inheritance, and environmental factors, using strategies outlined in Unit B.3 Inheritance and Variation of Trait Lesson 9, like a Gotta-Have-It Checklist, Small Group Charting, and Scientist Circle.
- 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.
    - Transfer task to evaluate claims about genetic inheritance and disease risk using data, models, and scientific reasoning, like the Lesson 10 “Genetics Transfer Task”.
- Explain the difference between Mendelian and non-Mendelian genetics (such as codominance, incomplete dominance, and sex-linked traits).
    - Read or watch a video about the ABO blood typing system and how it applies to multiple alleles and codominance.
    - Use a graphic organizer to highlight the way in which the ABO alleles are expressed.
    - For enrichment, perform a demonstration of or have students complete the blood simulation lab to demonstrate the ABO blood typing system and the inability to mix different types of blood together.
    - Play the “Nobel Prize Blood Typing” game to identify blood types and determine safe transfusions.
    - Supplement with Amoeba Sisters’s Genetic Series (Mendelian and Non-Mendelian) and corresponding Video Recap Worksheets.

    - (Optional) Read from Module 10 in the *Inspire Biology* textbook, Lesson 5, pages 273 - 276, which features incomplete dominance, codominance, and multiple alleles.
- Identify examples of applied genetics such as selective breeding, hybridization, inbreeding, and test crosses.
    - Watch the *National Geographic* documentary "Science of Dogs" (or something comparable) to witness a well-known, relatable example of selective breeding.
    - (Optional) Read from Module 10 in the *Inspire Biology* textbook, Lesson 3, pages 263 - 265, to identify ways in which breeding patterns can impact the inheritance patterns of certain populations of species.
- Evaluate the effects of new biotechnologies on society, including ethical implications.
    - Read scientific articles, such as a National Geographic article on Genetic Technology, that highlight advancements in biotechnology and allow for a discussion of the pros and cons of the procedures.
    - Watch credible videos, such as a nature video on CRISPR technology, that highlight advancements in biotechnology and allow for a discussion of the pros and cons of the procedures.
    - Read "A Question of Ethics" on page 315 in *Inspire Biology*, which references the story of Henrietta Lacks and her HeLa cells.

Correspondent Vocabulary:

- DNA, Nucleotide, Double Helix, Replication, Complementary base pairs, DNA Helicase, DNA Polymerase, Cell cycle, Interphase, Mitosis, Prophase, Metaphase, Anaphase, Telophase, Cytokinesis, Chromosome, Sister Chromatid, Centromere, Spindle Fiber, Pole, Equator, Cell Membrane, Nucleus, Cancer, Cyclin, Regulatory, Checkpoint, Tumor, Benign, Malignant, Metastasis, Nutrient, Sexual and Asexual Reproduction, Meiosis, Gamete, Somatic, Dipoid, Haploid, Homologous, Fertilization, Zygote, Crossing-over, Independent Assortment, Nondisjunction, Duplication, Translocation, Deletion, Insertion, and Inversion, Karyotype, mRNA, tRNA, rRNA, Ribosome, Protein Synthesis, Amino Acid, Transcription, Translation, Codon, Anti-codon, Mutation, Heredity, Relative, Gene expression, Allele, Trait, Offspring, Inheritance, Variation, Dominant, Recessive, Genotype, Phenotype, Probability, Punnett Square, Pedigree, Codominance, Incomplete dominance, Sex-linked trait, Polygenic, Multiple alleles, Melanoma, Chemotherapy, Radiation, Surgery, Immunotherapy, Social determinants of health, Health equity, Genetic engineering, Selective breeding, Inbreeding, Hybridization, Gene splicing, Cloning, Genetically modified organisms, Gene therapy

Assessments:

- **Diagnostic:**
    - Classroom Diagnostic Tools (CDT)
    - Teacher questioning and observation
    - Vocabulary manipulatives
    - Warm-up activities
    - Notice and Wonder Charts
    - Driving Question Board
    - Initial Models

- **Formative:**
  - Teacher questioning and observation
  - Group activities
  - Performance-based assessments
  - Independent worksheets
  - Vocabulary/visual manipulatives
  - Interactive digital manipulatives
  - Laboratory Exercises
  - Graphic Organizers
  - Activities and Review Games - Examples: *Quizizz or Kahoot*
  - Quizzes (as determined by the collective team)
  - Claim-Evidence-Reasoning or equivalent writing exercise
  - Collected student work samples - Examples: Science Notebook or Models
  - Exit Tickets
  - Peer Feedback
  - Progress Trackers
  - Student self-assessment

- **Summative:**
  - Transfer Task(s)
  - DNA Structure and Function Assessment
  - Cell Cycle and Mitosis Assessment
  - Meiosis and Karyotyping Assessment
  - Inheritance and Variation of Traits Assessment

- **Correctives:**
  - Give students supplemental vocabulary review materials
  - Give students web-based resources that reinforce the material presented in class
  - Give students extra practice for understanding the processes of cell replication and division
  - Give students extra practice for understanding the processes of DNA replication and protein synthesis
  - Give students extra practice predicting inheritance (Karyotypes, Punnett Squares, Pedigrees)
  - Keystone-Style Data Interpretation Activities using teacher-created question sets aligned to STEELS standards
  - Reteach and retest important concepts including essential vocabulary

- **Extensions:**
  - Explore a particular body system, how it functions, and how cancer disrupts that function
  - Research the discovery of the structure of DNA in the 1950s by scientists, including James Watson, Francis Crick, and Rosalind Franklin

- Consider the structure and function of the protein based on the side chains (charge) of the amino acids
- Analyze different types (mineral and chemical) of sunscreens
- Guided Reading of Supplemental Resources
- Interactive Activities on Websites
- Video Resources

Unit 6: **Diversity of Life, STEM and Laboratory Exploration, and Science Skill Enrichment (25 Days)**

- **Standards:**
  - **3.1.9-12.B** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
    - **Clarifying Statement:**
      - Emphasis is on functions at the organism system level, such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system. Assessment Boundary:
    - **Assessment Boundary:**
      - Assessment does not include interactions and functions at the molecular or chemical reaction levels.

  - **3.1.9-12.C** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
    - **Clarifying Statement:**
      - Emphasis is on functions at the organism system level, such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.
    - **Assessment Boundary:**
      - Assessment does not include interactions and functions at the molecular or chemical reaction levels.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• Developing and Using Models	• Structure and Function	• System and System Models

- **Anchoring Phenomena:**
  - Scientists use observations, evidence, and reasoning to make predications and theorize explanations about the natural world. (Amoeba Sisters's Nature of Science)

Objectives:

- Identify and evaluate evidences supporting different hypotheses about early Earth and biotic origins (DOK 1, 4)

- Name the six kingdoms of life as they are currently identified (DOK 1)
- Explain what the tree of life represents (DOK 1)
- Compare and contrast bacteria and viruses from Cellular Biology Unit (DOK 3)
- Summarize some major characteristics of protists (DOK 2)
- Summarize some major characteristics of fungi (DOK 2)
- Summarize some major characteristics of plants (DOK 2)
- Summarize some major characteristics of animals (DOK 2)
- Students will compare and contrast the animal phyla (DOK 2)
- Students will learn about the animal organ systems and their major features and structures (DOK 2)
- Students may dissect an earthworm, flower, and frog to learn about anatomical features and physiological function (DOK4)
- Review characteristics of all living things.
- Review cellular and ecological organization.
- Review chemistry of life.
- Review the nature of science and basic biological principles
- Review matter and energy in ecosystems.
- Review inheritance and genetic variation.

Core Activities and Corresponding Instructional Methods:

- Investigate major themes of the unit that correspond to lessons and activities to *Encounter the Phenomenon,* complete *BioLab Activities,* review *Vocabulary terms*, and the *Go Further Data Analysis Lab* as provided in the Inspire textbook series.
- Read from Modules 16-20 in the *Inspire Biology* textbook, to review major features of all kingdoms of life.
- Read from Modules 22-27 in the *Inspire Biology* textbook, to review major features animal anatomy and physiology.
- Compare and contrast different eukaryotic phyla.
    - Create Venn Diagrams and charts with descriptions and example species.
    - Use dissections of choice such as the flower, the earthworm, the starfish, and the frog dissection to allow students the opportunity to investigate characteristics of organisms in various animal phyla.
- Endangered or Keystone Species activity.

Assessments:

- **Diagnostic:**
    - Biology Classroom Diagnostic Tool (CDT)
    - Teacher questioning and observation

- **Formative:**
    - Teacher observations, questioning techniques
    - Define Vocabulary words for this unit
    - Group activities
    - Homework – example problems from the textbook and workbook for each section
    - Quizzes/graded assignments

- **Summative:**
    - Any remaining dissections - Earthworm, Flower, and Frog Dissections
    - Final Common Assessment

- **Correctives:**
    - Give students supplemental vocabulary review materials
    - Give students web-based resources that reinforce the material presented in class
    - Keystone-Style Data Interpretation Activities using teacher-created question sets aligned to STEELS standards
    - Reteach and retest important concepts including essential vocabulary

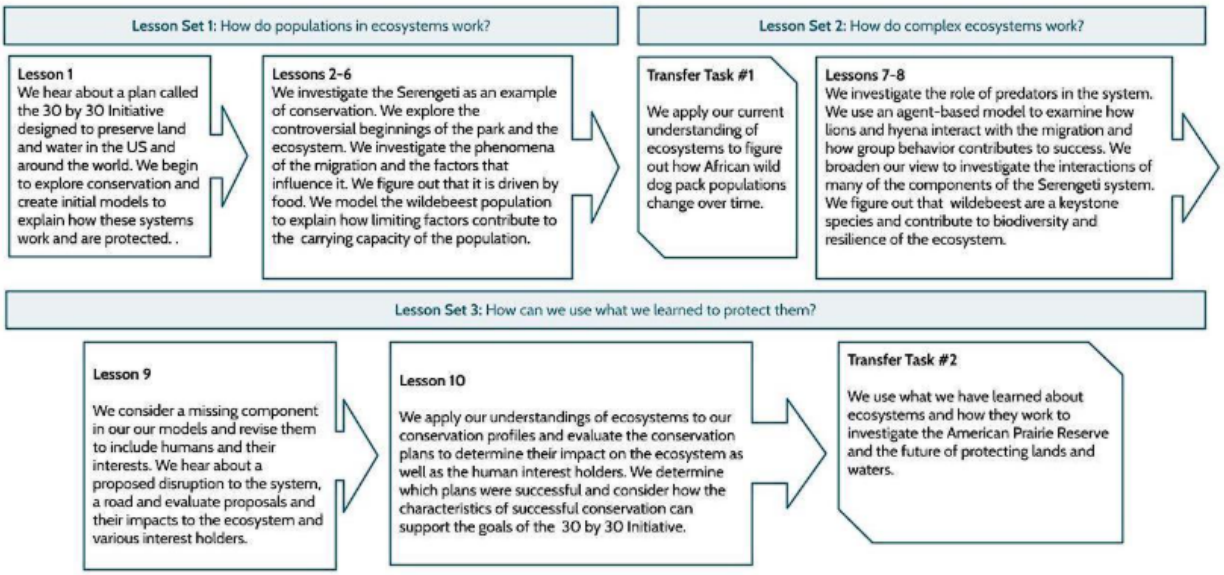
- **Extensions:**
    - Guided Reading of Supplemental Resources
    - Interactive Activities on Websites
    - Video Resources

Appendix A: Core Instructional Sequence

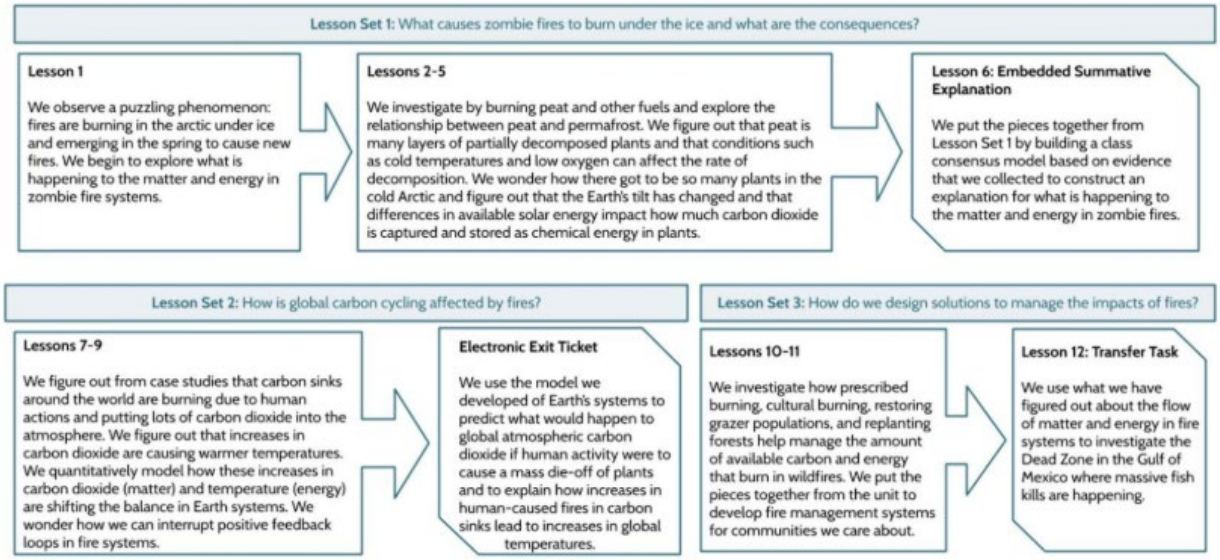
Instructional Strategy	Example	Purpose
Initial Model	• Collage board • Video • Model • Demonstration • Image/graphic • Reading	• Generate student interest • Activate prior knowledge
Driving Question Board	• Poster with sticky notes • Electronic Discussion Board (Example: Padlet) • Journal Entry • Whiteboards	• Students share ideas • Students write about their thoughts • Students make predictions • Students come to a consensus to drive the unit of study • Allows for diagnostic assessment
Student Investigation (Small group based when applicable)	• Student lab activity • Student analysis of demonstration • Simulation or interactive manipulatives • Read a passage • Hands-on activity and/or analysis	• Students formulate their own ideas and gather information/data about the phenomenon • Information informs/supports classroom consensus • Allows for formative assessment
Classroom Consensus Model	• Whole-class display • Revisit driving question board	• Whole-group discussion • Answer questions from the driving question board • Allows for formative assessment • Allows for peer and self-assessment
Correctives	• Focus on key vocabulary • Provide visuals and supporting details • Provide supplemental examples	• Prepare students to be able to employ skills learned for a new and applicable scenario • Allows for formative or summative assessment
Summative Assessment	• Transfer tasks (available on OpenSciEd) • Claim-Evidence-Reasoning (CER) • Constructed Response (CR) • Exit tickets (available on OpenSciEd) • Multiple Choice/Matching Questions	• Students demonstrate their knowledge of the unit standards • Students demonstrate their ability to apply their unit skills to comparable scenarios

Appendix B: Open-SciEd Unit B Flow Charts

Open-SciEd Unit B.1



Open-SciEd Unit B.2



Open-SciEd Unit B.3

