Shelby County Schools Science Vision

Shelby County Schools' vision of science education is to ensure that from early childhood to the end of the 12th grade, all students have heightened curiosity and an increased wonder of science; possess sufficient knowledge of science and engineering to engage in discussions; are able to learn and apply scientific and technological information in their everyday lives; and have the skills such as critical thinking, problem solving, and communication to enter careers of their choice, while having access to connections to science, engineering, and technology.

To achieve this, Shelby County Schools has employed The Tennessee Academic Standards for Science to craft meaningful curricula that is innovative and provide a myriad of learning opportunities that extend beyond mastery of basic scientific principles.

Introduction

In 2014, the Shelby County Schools Board of Education adopted a set of ambitious, yet attainable goals for school and student performance. The District is committed to these goals, as further described in our strategic plan, Destination 2025. In order to achieve these ambitious goals, we must collectively work to provide our students with high quality standards aligned instruction. The Tennessee Academic Standards for Science provide a common set of expectations for what students will know and be able to do at the end of each grade, can be located in the Tennessee Science Standards Reference. Tennessee Academic Standards for Science are rooted in the knowledge and skills that students need to succeed in post-secondary study or careers. While the academic standards establish desired learning outcomes, the curriculum provides instructional planning designed to help students reach these outcomes. The curriculum maps contain components to ensure that instruction focuses students toward college and career readiness. Educators will use this guide and the standards as a roadmap for curriculum and instruction. The sequence of learning is strategically positioned so that necessary foundational skills are spiraled in order to facilitate student mastery of the standards.

Our collective goal is to ensure our students graduate ready for college and career. Being College and Career Ready entails, many aspects of teaching and learning. We want our students to apply their scientific learning in the classroom and beyond. These valuable experiences include students being facilitators of their own learning through problem solving and thinking critically. The Science and Engineering Practices are valuable tools used by students to engage in understanding how scientific knowledge develops. These practices rest on important "processes and proficiencies" with longstanding importance in science education. The science maps contain components to ensure that instruction focuses students toward understanding how science and engineering can contribute to meeting many of the major challenges that confront society today. The maps are centered around five basic components: the Tennessee Academic Standards for Science, Science and Engineering Practices, Disciplinary Core Ideas, Crosscutting Concepts, and Phenomena.

The Tennessee Academic Standards for Science were developed using the National Research Council's 2012 publication, A Framework for K-12 Science Education as their foundation. The framework presents a new model for science instruction that is a stark contrast to what has come to be the norm in science classrooms. Thinking about science had become memorizing concepts and solving mathematical formulae. Practicing science had become prescribed lab situations with predetermined outcomes. The framework *proposes a three-dimensional approach to science education that capitalizes on a child's natural curiosity. The Science Framework for K-12 Science Education* provides the blueprint for developing the effective science practices. The *Framework* expresses a vision in science education that requires students to operate at the nexus of three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. The *Framework* identified a small number of disciplinary core ideas that all students should learn with increasing depth and sophistication, from Kindergarten through grade twelve. Key to the vision expressed in the *Framework* is for students to learn these disciplinary core ideas in the context of science and engineering practices. The importance of combining Science and Engineering Practices, Crosscutting Concepts and Disciplinary Core Ideas is stated in the *Framework* as follows:

Standards and performance expectations that are aligned to the framework must take into account that students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the discourses by which such ideas are developed and refined. At the same time, they cannot learn or show competence in practices except in the context of specific content. (NRC Framework, 2012, p. 218)

To develop the skills and dispositions to use scientific and engineering practices needed to further their learning and to solve problems, students need to experience instruction in which they use multiple practices in developing a particular core idea and apply each practice in the context of multiple core ideas. We use the term "practices" instead of a term such as "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Students in grades K-12 should engage in all eight practices over each grade band. Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. Crosscutting concepts have value because they provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas. There are seven crosscutting concepts that bridge disciplinary boundaries, uniting core ideas throughout the fields of science and engineering. Their purpose is to help students deepen their understanding of the disciplinary core ideas and develop a coherent and scientifically based view of the world.

The map is meant to support effective planning and instruction to rigorous standards. It is *not* meant to replace teacher planning, prescribe pacing or instructional practice. In fact, our goal is not to merely "cover the curriculum," but rather to "uncover" it by developing students' deep understanding of the content and mastery of the standards. Teachers who are knowledgeable about and intentionally align the learning target (standards and objectives), topic, text(s), task, and needs (and assessment) of the learners are best-positioned to make decisions about how to support student learning toward such mastery. Teachers are therefore expected--with the support of their colleagues, coaches, leaders, and other support providers--to exercise their professional judgment aligned to our shared vision of effective instruction, the Teacher Effectiveness Measure (TEM) and related best practices. However, while the framework allows for flexibility and encourages each teacher/teacher team to make it their own, our expectations for student learning are non-negotiable. We must ensure all of our children have access to rigor—high-quality teaching and learning to grade level specific standards, including purposeful support of literacy and language learning across the content areas.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions & defining problems 2. Developing & using models 3. Planning & carrying out investigations 4. Analyzing & interpreting data 5. Using mathematics & computational thinking 6. Constructing explanations & designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, & communicating information	**Physical Science** **PS 1:** Matter & its interactions **PS 2:** Motion & stability: Forces & interactions **PS 3:** Energy **PS 4:** Waves & their applications in technologies for information transfer **Life Sciences** **LS 1:** From molecules to organisms: structures & processes **LS 2:** Ecosystems: Interactions, energy, & dynamics **LS 3:** Heredity: Inheritance & variation of traits **LS 4:** Biological evaluation: Unity & diversity **Earth & Space Sciences** **ESS 1:** Earth's place in the universe **ESS 2:** Earth's systems **ESS 3:** Earth & human activity **Engineering, Technology, & the Application of Science** **ETS 1:** Engineering design **ETS 2:** Links among engineering, technology, science, & society	1. Patterns 2. Cause & effect 3. Scale, proportion, & quantity 4. Systems & system models 5. Energy & matter 6. Structure & function 7. Stability & change

Learning Progression

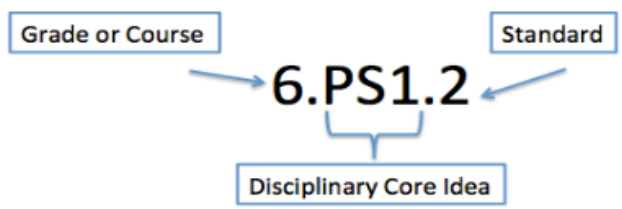
At the end of the elementary science experience, students can observe and measure phenomena using appropriate tools. They are able to organize objects and ideas into broad concepts first by single properties and later by multiple properties. They can create and interpret graphs and models that explain phenomena. Students can keep notebooks to record sequential observations and identify simple patterns. They are able to design and conduct investigations, analyze results, and communicate the results to others. Students will carry their curiosity, interest and enjoyment of the scientific world view, scientific inquiry, and the scientific enterprise into middle school.

At the end of the middle school science experience, students can discover relationships by making observations and by the systematic gathering of data. They can identify relevant evidence and valid arguments. Their focus has shifted from the general to the specific and from the simple to the complex. They use scientific information to make wise decision related to conservation of the natural world. They recognize that there are both negative and positive implications to new technologies.

As an SCS graduate, former students should be literate in science, understand key science ideas, aware that science and technology are interdependent human enterprises with strengths and limitations, familiar with the natural world and recognizes both its diversity and unity, and able to apply scientific knowledge and ways of thinking for individual and social purposes.

Structure of the Standards

- Grade Level/Course Overview: An overview that describes that specific content and themes for each grade level or high school course.
- Disciplinary Core Idea: Scientific and foundational ideas that permeate all grades and connect common themes that bridge scientific disciplines.
- Standard: Statements of what students can do to demonstrate knowledge of the conceptual understanding. Each performance indicator includes a specific science and engineering practice paired with the content knowledge and skills that students should demonstrate to meet the grade level or high school course standards.



Purpose of Science Curriculum Maps

This map is a guide to help teachers and their support providers (e.g., coaches, leaders) on their path to effective, college and career ready (CCR) aligned instruction and our

pursuit of Destination 2025. It is a resource for organizing instruction around the Tennessee Academic Standards for Science, which defines what to teach and what students need to learn at each grade level. The map is designed to reinforce the grade/course-specific standards and content (scope) and provides *suggested* sequencing, pacing, time frames, and aligned resources. Our hope is that by curating and organizing a variety of standards-aligned resources, teachers will be able to spend less time wondering what to teach and searching for quality materials (though they may both select from and/or supplement those included here) and have more time to plan, teach, assess, and reflect with colleagues to continuously improve practice and best meet the needs of their students.

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Unit 1 Cellular Structures & Energy Processes	Unit 2 Cell Division & Reproduction	Unit 3 Genetics	Unit 4 Evolution	Unit 5 Ecology
9 Weeks	8 Weeks	9 Weeks	6 Weeks	4 Weeks

Unit 1- Cellular Structures & Energy Processes

The Overarching Question(s)

- **Why are some structures, such as DNA, RNA, and the cell membrane, found in the cells of all organisms? Why do you think other structures, such as the nucleus, are only found in cells of certain kinds of organisms?**
- **What cellular structures and processes support day-to-day life?**

DCI, Standard, Explanations, Misconceptions Length [5 days]	Essential Questions, Learning Outcomes, Phenomena	3-Dimensional Instructional Approach (SEPs and CCCs) **Suggestions*	Vocabulary and Curricular Materials
DCI BIO1.LS1: From Molecules to Organisms: Structures and Processes **Standard** BIO1.LS1.1 Compare and contrast existing models, identify patterns, and use structural and functional evidence to analyze the characteristics of life. Engage in argument about the designation of viruses as non-living based on these characteristics. **students will revisit viral reproductive cycles in greater depth in the later parts of the Heredity unit.* **Explanation** Students begin to develop patterns of living and nonliving organisms in kindergarten and build on detailed characteristics of different classifications of living organisms throughout elementary and middle school. Biology 1 discussions introduce viral particles and viral cycles, building on student understanding of living organisms to engage in an argument regarding the classification of a viral particle as either living or non-living. **Misconceptions** Homeostasis is essential for organisms to survive because cells require relatively constant conditions to function properly. If these conditions are not met, many processes, such as protein synthesis and the	**Essential Questions** • What characteristics do all living things share? • Why is it important for organisms to maintain homeostasis? **Learning Outcomes (*Possible Objectives)*** • Identify the characteristics that all living things share. • Construct an argument from evidence explaining why viruses are not living. **Phenomenon** Viral Particles ~ Alive or Not? Using the characteristics of life, construct an argument from evidence explaining why viruses are not living.  Are synthetic cells life? ~ Watch the following clip from ABC news. Using the information, you know about the characteristics of life, determine if the	**Science and Engineering Practice** Engaging in an argument from evidence *Students critically evaluate evidence supporting an argument and create written or oral arguments that invoke empirical evidence, scientific reasoning and scientific explanations.* **Cross Cutting Concepts** Patterns *Students recognize, classify, and record patterns in quantitative data from empirical research and mathematical representations.* Structure and Function *Students apply patterns in structure and function to unfamiliar phenomena and infer the function of a component of a system based on its shape and interactions with other components.*	**Vocabulary** cells, DNA, metabolism, homeostasis, evolution, biology, sexual reproduction, asexual reproduction, stimulus, evolve **Lessons** **Lesson 1: What are the characteristics of life?** **Days 1-3** **SEP: Asking Questions and defining problems** **CCC: Patterns** **Textbook** Miller & Levin Chapter 1 ~ The Science of Life 1.3 ~ Patterns in Life, pgs. 22-29, 242-247, 266-269 **Laboratory Activities/Investigations** Studying Life Studying Life Lab Characteristics of Life Walk-around Laboratory Walk-Around Lab **Simulations** Interactive Video ~ Characteristics of Life **Articles** What exactly is life? What is Life? Researchers may have solved the origin of life conundrum Origin of Life **Lesson 2: Is it alive?** **Days 4-5**

transport of substances across cell membranes, will not occur. Viruses are alive ~ Viral particles have some of the characteristics of life, but not all of them. In particular, viruses do not respond to stimuli, viruses do not reproduce without the use of host cell machinery and materials, viruses	cells that were created in the laboratory are "alive." Construct an argument defending whether these cells are alive or not alive https://www.youtube.com/watch?v=aRzrYNVXF2		**SEP: Engaging in argument from evidence** **CCC: Structure and Function** **Laboratory Activities/Investigations** Case Study~ "Life, the final Frontier" Life Case Study Are Viruses Alive? Viral Life **Performance Tasks** Argument from evidence ~ Students will be given data to analyze about a new possible life form found by the Mar's Exploration Program. Using the data, they will have to construct and argument stating their opinion for or against the new material being called a life form. Mars Life

DCI, Standard, Explanations, Misconceptions Length [7 days]	Essential Questions, Learning Outcomes, Phenomena	3-Dimensional Instructional Approach (SEPs and CCCs)	Vocabulary and Curricular Materials
DCI BIO1.LS1: From Molecules to Organisms: Structures and Processes **Standard** BIO1.LS1.2 Evaluate comparative models of various cell types with a focus on organic molecules that make up cellular structures. **Explanation** Students explicitly discuss the structure and function of major cellular organelles in seventh grade. Building on this understanding, Biology I students should shift their focus to the different types of cells found in organisms and how the role of each cell type relates to its composition and the prevalence of different organelles within that cell. An example might include the absence of the nucleus (or enucleation) in red blood cells in mammals providing for increased levels of oxygen transport in organisms or the lack of centrioles in most neurons. Varying cell types can include both prokaryotic and eukaryotic cell types. **Misconceptions** • Prokaryotic cells have no DNA ~ These cells have DNA, but not have a nucleus. • Plant cells have chloroplasts, but not mitochondria ~ Plant cells have both	**Essential Questions** • What are the major classes of biological molecules? • How do prokaryotic and eukaryotic cells differ? • What are the functions of the major cellular organelles? • How might a cell's structure change the composition of cellular organelles and their functions? **Learning Outcomes** • Identify the major classes of biological molecules and their functions. • Identify the major cellular organelles. • Analyze differences between different cell types, and their organelles. • Construct an argument from evidence about what organelles might be present in specific cell types. **Phenomenon** The differentiation of cells in the human body~ The cells of the human body all begin the same, but they modify their cellular components based on their functions. Thinking about the needs of the different cells, make predictions of the cellular organelles that the cells will need to perform those functions.	**Science and Engineering Practice** Developing and using models *Students can test the predictive abilities of their models in a real-world setting and make comparisons of two models of the same process or system* **Cross Cutting Concepts** Systems and System Models *Students create and manipulate a variety of different models: physical, mathematical, computational*	**Vocabulary** Atom, nucleus, electron, element, isotope, compound, ionic bond, ion, covalent bind, molecule, van der Waals forces, monomer, polymer, carbohydrate, lipid, nucleotide, nucleic acid, protein, amino acid, cell, cell theory, cell membrane, nucleus, eukaryote, prokaryote, cytoplasm, organelle, ribosome, endoplasmic reticulum, golgi apparatus, vacuole, lysosome, cytoskeleton, chloroplast, mitochondrion, cell wall, lipid bilayer, selectively permeable, tissue, organ, organ system, receptor **Lessons** **Lesson 1: Carbon Compounds** **Days 1-3** **SEP: Developing and Using Models** **CCC: System and System Models** **Textbook Materials** Miller & Levin Chapter 2 ~ The Chemistry of Life 2.1 ~ The Nature of Matter (Reference) 2.3 ~ Carbon Compounds p. 52-57 **Video (Use as an introduction to lesson)** Chemistry of Durian Fruits Durian Fruits Class discussion about the wide variety of carbon compound and how essential the element (carbon) is to life. **Laboratory Activities/Investigations**

chloroplasts and mitochondria, as they must perform both photosynthesis and cellular respiration. • The organelles are free floating in the cytoplasm ~ Organelles are numerous and are held in place by the cytoskeleton.	Differentiation		Case Study ~ Something is missing. But what? P. 41 Analyzing Data ~ Trace Elements p. 54 **Lesson 2: Cell Structure and Functions** **Days 4-7** **SEP:** Developing and Using Models; Planning and carrying out Investigations; Engaging in Argument with Evidence **CCC:** Structure and Function **Textbook Materials** Miller & Levin Chapter 8 ~ Cell Structure and Function 8.1 ~ Life is Cellular pgs. 242-247 8.2 ~ Cell Structure pgs. 8.4 ~ Homeostasis and Cells **Laboratory Activities/Investigations** Case Study ~ What's Happening to me? p. 241 Quick Lab ~ What Is a Cell? p. 243 Open-Ended Inquiry ~ How can you make a model of a cell? P.255 Analyzing Data ~ Mitochondria in a Mouse p. 268 Specialized cells interactive Interactive What Leeuwenhoek Saw Leeuwenhoek **Simulations** Cystic Fibrosis Video CF Video Cell Explorer Activity Cell Explorer The Operating System of Life OS of Life **Articles** Bone Cell Signaling Bone Cell Signaling **Performance Tasks** Special Cells ~ Students will research a specific cell type found in an animal, and a specific cell type found in a plant, and will create a poster to explain the similarities and differences between the two cell types.

DCI, Standard, Explanations, Misconceptions Length [5 days]	Essential Questions, Learning Outcomes, Phenomena	3-Dimensional Instructional Approach (SEPs and CCCs)	Vocabulary and Curricular Materials
DCI BIO1.LS1: From Molecules to Organisms: Structures and Processes **Standard** BIO1.LS1.5 Research examples that demonstrate the functional variety of proteins and construct an argument based on evidence for the importance of the molecular structure to its function. Plan and carry out a controlled investigation to test predictions about factors, which should cause an effect on the structure and function of a protein. **Explanation** Focus of this standard is on the activities of proteins and the role of the structure of proteins in carrying out these activities. Students can be reminded of the concept of reversible and irreversible changes addressed in earlier physical science standards. Investigations might include the effect of amylase activity on a starch substrate as a function of varying temperature or another independent variable. Roles of proteins include cellular regulation, cell signaling, enzymatic function, and structural components **Misconceptions** • Solutions only consist of solids and liquids ~ Solutions can involve different states of matter • Energy is released to break bonds ~ Energy is required to break bonds, and energy is released when new bonds form. It is the net energy change in energy that determines whether the chemical change overall releases or absorbs energy. • Enzymes give energy to the substrates to decrease the activation energy ~ Enzymes are not used in a chemical reaction. They do not provide energy for a reaction, they put the substrates into the right conformation to allow the chemical reaction to proceed	**Essential Questions** • How is the structure of water important to its role within the cell? • How are a protein's structure and function related? • What is the role of enzymes on biochemical reactions within the cell? **Learning Outcomes** • Explain the importance of protein structure and function • Conduct investigations into environmental variables which can affect protein function • Predict changes in enzyme function due to environmental variables **Phenomenon** Snake Venom ~ When a venomous snake bites a prey animal, it releases an enzyme which can be categorized as either a neurotoxin, cytotoxin or haemotoxin. Haemotoxic venom destroys red blood cells, disrupts clotting, or damages organs. Is a fever good for you? ~ When we are infected with a viral or bacterial pathogen, the body responds by increasing the core body temperature. Most of us would respond by attempting to decrease that temperature, through the use of analgesics. However, a mild increase in body temperature increases the activity of the enzymes in the body's defense cells, white blood cells, while, at the same time, decreasing the activity of viral and bacterial enzymes. Cancer protein structure Cancer Protein	**Science and Engineering Practice** Planning and carrying out controlled investigations *Students plan and perform investigations to aid in the development of a predictive model for interacting variables, considering the quantity of data with respect to experimental uncertainty, and select methods for collection and analysis of data.* **Cross Cutting Concepts** Structure and Function *Students create and manipulate a variety of different models: infer the function of a component of a system based on its shape and interactions with other components*	**Vocabulary** Hydrogen bond, cohesion, adhesion, mixture, solution, solute, solvent, suspension, pH scale, acid, base, buffer, chemical reaction, reactant, product, activation energy, catalyst, enzyme, substrate **Lessons** **Lesson 1 ~ Water and Life** **Day 1** **SEP: Obtaining, evaluating, and communicating information** **CCC: Structure and Function** **Textbook Materials** Miller & Levin Chapter 2 ~ The Chemistry of Life 2.2 ~ Properties of Water **Laboratory Activities/Investigations** Properties of water ~ Properties of Water **Lesson 2 ~ Enzymatic Reactions** **Days 2-5** **SEP: Planning and carrying out controlled investigations; Analyzing and interpreting data** **CCC: Structure and Function** **Textbook Materials** Miller & Levin Chapter 2 ~ The Chemistry of Life 2.4 ~ Chemical Reactions and Enzymes **Laboratory Activities/Investigations** Enzyme Activity Pasco Lab Vernier Lab Enzymatic Browning Activity Browning Lab Enzymatic Digestion Laboratory Digestion Lab **Simulations** Optimal Enzyme Activity Optimal Enzyme Paperase Paperase Enzyme Controlled Reactions Reactions **Articles** Fly on the most wanted list Fly Article How could dragons breathe fire? Dragon Article Climate change and food Climate and Food **Performance Tasks** Disease due to lack of protein ~ Students will

			research diseases caused by a lack of protein, and create a presentation which shares the features of the disease, including causes, locality, signs and symptoms, and treatments.

DCI, Standard, Explanations, Misconceptions Length [3 days]	Essential Questions, Learning Outcomes, Phenomena	3-Dimensional Instructional Approach (SEPs and CCCs)	Vocabulary and Curricular Materials
DCI BIO1.LS1: From Molecules to Organisms: Structures and Processes **Standard** BIO1.LS1.7 Utilize a model of a cell plasma membrane to compare the various types of cellular transport and test predictions about the movement of molecules into or out of a cell based on the homeostasis of energy and matter in cells **Explanation** Students are first introduced to the structure of the plasma membrane and an initial discussion of passive transport to maintain homeostasis in the seventh grade. Biology I discussion of passive transport is still relevant, but discussions of transport should extend to include additional types of cellular transport, and how they are accomplished by proteins embedded in the plasma membrane **Misconceptions** • Most materials are transported into and out of cells through active transport ~ Most things move through passive transport	**Essential Questions** • How does the cell move materials through the plasma membrane? • What role does cellular transport play in the maintenance of homeostasis? **Learning Outcomes** • Explain the various modes of cellular transport • Create and test a prediction about the movement of molecules across a membrane. **Phenomenon** What would happen to a human if they were given an IV full of pure water? ~ As the blood stream increased the concentration of water, osmosis would increase into cells, leading to cellular swelling and possibly damage. There would also be problems with the concentration of ions and proteins within the blood, leading to issues with cellular signaling.	**Science and Engineering Practice** Developing and using models *Students can test the predictive abilities of their models in a real-world setting and make comparisons of two models of the same process or system* **Cross Cutting Concepts** Systems and System Models *Students create and manipulate a variety of different models: physical, mathematical, computational*	**Vocabulary** Homeostasis, diffusion, facilitated diffusion, aquaporin, osmosis, isotonic, hypertonic, hypotonic, osmotic pressure, tissue, organ, organ system, receptor, specialization **Lessons** **Lesson 1 - Cellular Transport** **Days 1-2** **SEP: Developing and Using Models** **CCC: Energy & Matter** **Textbook Materials** Miller & Levin Chapter 8 8.3 ~ Cell Transport pgs. 260-265 **Laboratory Activities/Investigations** Open-Ended Inquiry ~ Detecting Diffusion p.261 PHeT Cell Membrane Interactive https://phet.colorado.edu/en/simulation/legacy/membrane-channels **Simulations** Interactive ~ Osmosis Cell Defense: The Plasma Membrane Game **Articles** Reverse Osmosis and Space Travel Space Article Lionfish and osmosis Lionfish Article **Case Study** Mitochondria in a Mouse, pg. 268 **Performance Tasks** Water, water everywhere ~ Students will research the water crisis in South Africa. Students will then research different methods to create drinking water from available water resources and create an

			argument for the method they this is best as a valid solution to the water crisis in South Africa. **Lesson 2 - Homeostasis and Cells** **Day 3** **SEP: Constructing Explanations and Designing Solutions** **CCC: Structure and Function** **Textbook Materials:** Miller & Levin Chapter 8.4 ~ Homeostasis and Cells pgs. 266 – 271 **STEM Projects** Raising Algae for Biofuels - students design an experiment in which they efficiently raise algae. STEM Project **Simulations** Multicellular Life - Multicellular Simulation Maintaining Homeostasis ~ Homeostasis Simulation **Performance Tasks** Construct Explanations **–** Asks students to construct an explanation for how in terms of numbers, unicellular organisms dominate life on Earth. Write for a Specific Audience – Have small groups of students write a skit to present to a younger audience. The skit should include dialogue. For example, students might write a series of creative, content-based questions to interview a bacterium, a plant cell, and an animal cell to learn how each maintains homeostasis. Encourage groups to swap skits for peer review. ENG PRJ: Bioremediation Using Cells to Clean Up Pollution, pgs. 274-275

DCI, Standard, Explanations, Misconceptions Length [12 days]	Essential Questions, Learning Outcomes, Phenomena	3-Dimensional Instructional Approach (SEPs and CCCs)	Vocabulary and Curricular Materials
DCI BIO1.LS1: From Molecules to Organisms: Structures and Processes **Standard** BIO1.LS1.8 Create a model of photosynthesis demonstrating the net flow of matter and energy into a cell. Use the model to explain energy transfer from light energy into stored chemical energy in the product **Explanation** Students should address the processes used during photosynthesis to convert light energy (solar radiation) into stored chemical energy. Additionally, consider the role of photosynthesis in capturing carbon, hydrogen, and oxygen needed to produce other cellular macromolecules such as proteins and DNA necessary for growth and reproduction. The chemical reactions needed for constant reorganization of these elements to form new compounds provides a way to transfer energy between systems across all levels of organization. **Misconceptions** • Students think that there is a single reaction in which CO2 and H2O become sugar and oxygen ~ There are multiple steps and the two processes occur in different part of the chloroplasts. • The second phase of photosynthesis is called the dark reactions because they only happen when it is dark ~ The light-independent reactions can occur at any time, as they do not require sunlight.	**Essential Questions** • What is the function of ATP in cells? • How is energy transferred from light energy into stored energy in the cell? • What are the reactants and products of photosynthesis? • What factors affect photosynthesis? **Learning Outcomes** • Students can explain the role of ATP in the cell • Students can identify the energy transfer steps of photosynthesis • Students can identify and explain the role of the reactants and products of photosynthesis **Phenomenon** How does photosynthesis occur in plants which are not green? ~ Students have learned that photosynthesis occurs in the chloroplast, which reflects green light. There are plants which are not green, but which are still able to undergo photosynthesis. How do those plants photosynthesize? Photosynthesis Phenomenon	**Science and Engineering Practice** Planning and carrying out controlled investigations *Students plan and perform investigations to aid in the development of a predictive model for interacting variables, considering the quantity of data with respect to experimental uncertainty, and select methods for collection and analysis of data.* **Cross Cutting Concepts** Energy and Matter *Students explain the conservation of energy by discussing the transfer mechanisms between objects or fields as well as into or out of a system*	**Vocabulary** ATP, Photosynthesis, Pigment, Chlorophyll, Thylakoid, Stroma, NADP+, light-dependent reactions, light-independent reactions, photosystem, electron transport chain, ATP synthase, Calvin cycle **Lessons** **Lesson 1 – Energy and Life** **Days 1-4** **SEP: Developing and Using Models** **CCC: Energy and Matter** **Textbook Materials** Miller and Levin Chapter 9 ~ Photosynthesis 9.1 ~ Energy and Life, pgs. 282-285 **Laboratory Activities/Investigations** Case Study ~ What would it take to make an artificial leaf? p. 281 Quick Lab ~ How do Organisms capture and use energy p. 284 **Lesson 2 – Photosynthesis** **Days 5-8** **SEP: Developing and Using Models** **CCC: Energy and Matter**

			Textbook Materials 9.2 ~ Photosynthesis: An Overview, pgs. 287-290 **Laboratory Activities/Investigations** Light Wavelengths and Photosynthesis Light Wavelengths and Photosynthesis What color of light is most important for plant growth? Light and Growth Photosynthesis in Sugar Beets Case Study Case Study **Simulations** Interactive ~ the Effect of Light on the Rate of Photosynthesis Photosynthesis Interactive Photosynthesis Game **Lesson 3 – Process of Photosynthesis** **Days 9-12** **SEP: Developing and Using Models** **CCC: Energy and Matter** **Textbook Materials**

			9.3 ~ The Process of Photosynthesis, pgs. 291-297 **Laboratory Activities/Investigations** Open-Ended Inquiry ~ Plant Pigments and Photosynthesis p. 289 Photosynthesis Chemistry Model Photosynthesis Chemistry Photosynthesis Laboratory Photosynthesis Laboratory **Simulations** Interactive ~ ATP and batteries **Articles** "Bionic plants offer superpowered photosynthesis." Bionic Plants "Bionic leaf makes fuel from sunlight." Bionic Leaf "How did plants develop photosynthesis?" History of Photosynthesis **Performance Tasks** Mars Colonization ~ Oxygen is necessary for life on Earth. To colonize Mars, astronauts will be required to determine a method to produce oxygen, involving photosynthesis. Students will research the required materials that astronauts should take with

			them to produce enough oxygen to survive.

DCI, Standard, Explanations, Misconceptions Length [13 days]	Essential Questions, Learning Outcomes, Phenomena	3-Dimensional Instructional Approach (SEPs and CCCs)	Vocabulary and Curricular Materials
DCI BIO1.LS1: From Molecules to Organisms: Structures and Processes **Standard** BIO1.LS1.9 Create a model of aerobic respiration demonstrating flow of matter and energy out of a cell. Use the model to explain energy transfer mechanisms. Compare aerobic respiration to alternative processes of glucose metabolism **Explanation** In addition to models that explore the major reactions of cellular respiration, students should be led to consider the way that the chemical reactions of respiration provide a way for energy and matter captured using photosynthesis to be transferred and reorganized by consumers. Cellular respiration is a set of reactions that allow for sugars to be re-organized to form other macromolecules. Students should consider differences in the efficiencies of different processes of glucose metabolism. Some of the energy released by respiration is used to maintain a constant body temperature despite constant loss of thermal energy to the surroundings. Both matter and energy are conserved throughout transformations. **Misconceptions** Cellular respiration only takes place in animal cells, not plant cells ~ both plant and animal cells need to release the energy in food and store it as ATP. Energy is created during cellular respiration ~ Energy is transferred from glucose into a form useable by the cell, ATP. The purpose of fermentation is to produce a small amount of energy when cells don't have access to oxygen ~ Fermentation is primarily a recycling mechanism for NAD+ so that the cell can continue to make energy.	**Essential Questions** • What is the relationship between photosynthesis and cellular respiration? • What are the steps of cellular respiration? • How efficient are the steps of cellular respiration? • How does cellular respiration follow the laws of thermodynamics? Learning Outcomes • Students can explain how glucose is used to create ATP • Students can explain the difference in the efficiency of fermentation and cellular respiration • Students can explain why ectotherms eat less than endotherms **Phenomenon** How do muscles get the energy they need for athletic activity? ~ Cellular Respiration Phenomenon	**Science and Engineering Practice** Planning and carrying out controlled investigations *Students plan and perform investigations to aid in the development of a predictive model for interacting variables, considering the quantity of data with respect to experimental uncertainty, and select methods for collection and analysis of data.* **Cross Cutting Concepts** Energy and Matter *Students explain the conservation of energy by discussing the transfer mechanisms between objects or fields as well as into or out of a system*	**Vocabulary** Calorie, Cellular Respiration, Aerobic, Anaerobic, Glycolysis, NAD+, Krebs Cycle, Fermentation **Lessons** **Lesson 1 ~ Cellular Respiration Process** **Days 1-7** **SEP: Developing and using models** **CCC: Systems and System Models, Energy and Matter** **Textbook Materials** Miller and Levin Chapter 10 ~ Cellular Respiration 10.1 ~ Cellular Respiration: An Overview 10.2 ~ The Process of Cellular Respiration **Laboratory Activities/Investigations** Carbon Transfer Virtual Laboratory Carbon Transfer Mystery of the Flea Dip Flea Dip Chicago Cyanide Murders Cyanide Case Study Cellular respiration and exercise Exercise **Performance Tasks** Carb Crazy ~ Students will research low carbohydrate diets. They will then examine the method that the body uses to break down the biomolecules that are ingested on a low carbohydrate diet. Diets **Lesson 3 ~ Cellular Respiration Misconceptions** **Days 8-10** **SEP: Analyzing and interpreting data** **CCC: Energy and matter** **Laboratory Activities/Investigations** Cellular Respirations in Plants Plants and Cellular Respiration **Simulations** Energy in a Cell

			Cellular Energy **Articles** Ghost Redwoods Ghost Redwoods **Lesson 4 ~ Fermentation** **Days 11-13** **SEP: Planning and carrying out controlled investigations** **CCC: Energy and Matter** **Textbook Materials** Miller and Levin Chapter 10 ~ Cellular Respiration 10.3 ~ Fermentation **Laboratory Activities/Investigations** Fermentation Laboratory Fermentation Lab **Performance Task** Construct explanations ~ Students should explain what they predict the "perfect athlete's" muscles look like microscopically. They should include information about the ability of the athlete to produce and store ATP in various environments. They should then research what an athlete's muscles look like compared with an average adult, and see if their predictions were correct.