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

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

Disciplinary Core Ideas

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

Crosscutting Concepts

1. Patterns
2. Cause & effect
3. Scale, proportion, & quantity
4. Systems & system models
5. Energy & matter
6. Structure & function
7. Stability & change

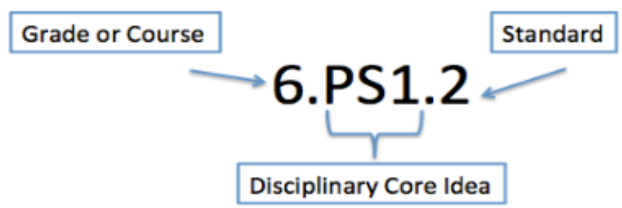
Learning ProgressionAt the end of the elementary science experience, students can observe and measure phenomena using appropriate tools. They are able to organize objects and ideas into broad concepts first by single properties and later by multiple properties. They can create and interpret graphs and 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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Biology Quarter 3 Curriculum Map Curriculum Map Feedback Survey				
Quarter 1	Quarter 2	**Quarter 3**	Quarter 4	
Unit 1 Cellular Structures & Energy Processes	Unit 2 Cell Division & Reproduction	**Unit 3 Genetics**	Unit 4 Evolution	Unit 5 Ecology
9 weeks	9 Weeks	**9 Weeks**	3 Weeks	6 Weeks

Unit 3 Genetics [9 Weeks]			
Overarching Question(s)			
How are characteristics of one generation passed to the next? How can individuals of the same species and even sibling have different characteristics?			
Unit, Lesson	**Lesson Length**	**Essential Question(s)**	**Vocabulary**
Unit 3 Heredity	4 Weeks	• What are the major modes of genetic inheritance? • How does a pedigree model inheritance pattern's? • How can a pedigree exhibit the various modes of inheritance?	Gene, Allele, Probability, Homozygous, Heterozygous, Phenotype, Genotype, Independent Assortment, Incomplete Dominance, Codominance, Multiple Alleles, Polygenic Trait,

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI(S) BIO1.LS3: Heredity **Standard** **BIO1.LS3.3** Through pedigree analysis, identify patterns of trait inheritance to predict family member genotypes. Use mathematical thinking to predict the likelihood of various types of trait transmission. **Explanation** As an introduction, ensure a common understanding of the components of a pedigree. The pedigree structure mimics social conventions and family structures common among western European societies but may be less familiar to students of non-western or non-traditional family structures. Pedigrees pre-date gene-sequencing techniques and serve as a data analysis tool to organize information about the transmission of a trait through generations. Cultural	**Learning Outcomes *(Possible Objectives)*** • Students can identify phenotype based on genotype • Students can identify the major modes of inheritance • Students can examine a genetic cross and predict the mode of inheritance • Students can analyze a pedigree for inheritance patterns • Students can predict the genotype of a person based on a pedigree **Phenomenon** Story: The Blue People of Kentucky Case Study: Those Old Kentucky Blues: An Interrupted Case Study Activity: The Blue People of Troublesome Creek	**Curricular Resources** **Engage** Inquiry Warm Up Lab: Analyzing Inheritance Drag and Drop Pedigree Dominant or Recessive Using Punnett Squares Beyond Dominant and Recessive Lily Breeding Human Inheritance Colorblindness **Explore** Genes and Blood Type: Sickle Cell Disease Hands on Genetics Understanding Variation Virtual Genetics Lab Observing Human Traits Laboratory Pedigree Investigator Pedigree Analysis

records and phenotypic observations allowed scientists to uncover patterns for transmission.

Agriculturally, references to conventions based on pedigrees are still a standard way to differentiate means of fertilization offspring (e.g., hybridized vs open pollinated).

Modes of inheritance should include autosomal and sex-linked genes that are dominant/recessive, codominant, or incompletely dominant. Students can practice deductive reasoning using a basic set of criteria (including successive generation transmission and male/female ratio) in order to predict a mode of inheritance for a trait, define alleles for the trait, and assign genotypes to the family members of a given pedigree. Students can also practice using probability-based mathematics to predict offspring genotypes and phenotypes based on a given parental set.

Misconceptions

- *Genes are the only thing that determine phenotype*. Environmental factors can also affect phenotype.
- *Most traits are coded for by a single gene*. Most traits are coded for by multiple genes
- *Dominant traits are the most common traits in a population.* Recessive traits can be the most common if they confer a selective advantage or are prevalent in a small population

Science and Engineering Practice

Analyzing and interpreting data.

Students should derive proportionalities and equalities for dependent variables which include multiple independent variables, considering uncertainty, and limitations of collected data.

Cross Cutting Concept

Pattern

Paul Karason and his girlfriend, Jackie Northrup.

Description: There is a population of people in rural Kentucky who are blue. This is a genetic trait that can be traced to a single person who moved into the area. Six generations after a French orphan named Martin Fugate settled on the banks of eastern Kentucky's Troublesome Creek with his redheaded American bride, his great-great-great-great-grandson was born in a modern hospital not far from where the creek still runs. The body had dark blue skin. "It was almost purple," his father recalls. Two days of tests produced no explanation for skin the color of a bruised plum. A transfusion was being prepared when Benjy's grandmother spoke up. "Have you ever heard of the Blue Fugates of Troublesome Creek?" she asked the doctors.

Explain

Sickle Cell Anemia Case Study
Lactose Inheritance
Bloodline Case Study

Elaborate

X-Linked Inheritance
The Making of Fitness: Natural Selection in Human (Sickle Cell Anemia) Part 1
The Making of Fitness: Natural Selection in Human (Sickle Cell Anemia) Part 2
Natural Selection in Humans Student Quiz
Mendelian Genetics, Pedigrees and Chi Square Statistics

Evaluate

Lesson 12.1 Review/ Lesson Quiz
Lesson 12.2 Review/ Lesson Quiz
Lesson 12.3 Review/ Lesson Quiz
Lesson 15.1 Review/ Lesson Quiz

Textbook Materials: Miller and Levine TN Biology
Ch. 12 Modes of Inheritance
Lesson 12.1 The Work of Gregor Mendel pg. 378-382
Lesson 12.2 Applying Mendel's Principals pgs. 383-388
Lesson 12.3 Other Patterns of Inheritance pgs. 389-392
Ch. 15 Human Chromosomes
Lesson 15.1 Human Chromosomes pgs. 474-479

Performance Task(s)

Chapter Case Study: Genetic Disorders: Understanding the Odds pgs. 376-377, 400-401
Chapter Performance Task: Growing More and Better Corn pgs. 404-405
Pedigree Case Study
HASPI Disease Mutation Activity (requires you to create a login, but has a number of resources for Biology) HASPI

SEP: Engaging in Argument from Evidence
Using any science-based argumentation strategy (CER, White Board, Round Robin, Socratic Method) students

Students recognize, classify, and record patterns in quantitative data from empirical research and mathematical representations		should engage in argument from evidence to justify that some traits are the result of dominant or recessive inheritance patterns that exists across generations. **Additional Resources** 5E Plan – Mechanics & Structure of Genetics

Biology Quarter 3 Curriculum Map				
Quarter 1	Quarter 2	**Quarter 3**	Quarter 4	
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9 weeks	9 Weeks	**9 Weeks**	3 Weeks	6 Weeks

Unit 3 Genetics [9 Weeks]			
Overarching Question(s)			
How are the characteristics of one generation related to the previous generation?			
Unit, Lesson	**Lesson Length**	**Essential Question**	**Vocabulary**
Unit 3 DNA, RNA, Proteins	3 Weeks	• What occurs during the process of DNA replication? • What are the three types of RNA molecules? • What are the structures and functions of the three types of RNA molecules? • How is RNA transcribed? • What post-translational modifications occur during RNA processing? • How are proteins translated? • What are the types of DNA mutations, and what effect do they have on transcription/translation?	Base Pairing, Replication, DNA polymerase, Telomere, RNA, messenger RNA, ribosomal RNA, transfer RNA, RNA polymerase, promoter, intron, exon, polypeptide, genetic code, codon, translation, anticodon, operon, operator, mutation, point mutation, frameshift mutation, mutagen, polyploidy

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI(S) **BIO1.LS1**: From Molecules to Organisms: Structures and Processes **BIO1.LS3**: Heredity **Standard** **BIO1.LS1.3** Integrate evidence to develop a structural model of a DNA molecule. **Using the model, develop and communicate an explanation for how DNA serves as a template for self-replication and encodes biological information.**	**Learning Outcomes *(Possible Objectives)*** • Students can model the process of DNA replication • Students can identify the three types of RNA and explain their structures and functions. • Students can accurately transcribe and translate an unknown gene • Students can explain the processes of post-translational modification • Students can identify the start and stop codons within a transcription sequence • Students can explain how DNA mutations modify proteins. **Phenomenon** Short Film: Malaria and Sickle Cell Anemia Film Quiz: Natural Selection in Humans-Sickle Cell Anemia	**Curricular Resources** **Engage** DNA replication DNA and RNA Reverse Transcription The Genetic Code Gene Regulation Fixing Gene Expression Transcribe and Translate a Gene What is a Mutation? Interactivity: Mutations **Explore** DNA replication How Can You Model DNA and RNA?

with emphasis on the replication portion of this standard.* **BIO1.LS1.4 Demonstrate how DNA sequence information is decoded through transcriptional and translational processes within the cell in order to synthesize proteins. Examine the relationship of structure and function of various types of RNA and the importance of this relationship in these processes. **BIO1.LS3.2** Explain how protein formation results in phenotypic variation and discuss how changes in DNA can lead to somatic or germ line mutations. **Explanation** Discussions of DNA in earlier grades have been limited to discussions of genes and the role of genes in the appearance and activities of organism. Biology 1 represents a student's introduction to a molecular model of DNA as well as the organization of DNA into genes and genes subsequently into chromosomes. Students should address interactions between genes in proteins which regulate both the shape and reproduction of DNA molecules. It is important to note that not all segments of DNA are transcribed for proteins. Portions of DNA are involved in regulating the expression of genes or affect the structure of the chromosomes	Lesson: Sickle Cell Disease and Malaria: A Lesson on the Nature of Science  **Description**: Sickle-cell anemia is caused by a single nucleotide mutation in the β-globin gene of red blood cells. This creates incorrectly structured proteins and red blood cells with a characteristic "sickle" shape. This harmful mutation does not affect carriers of the disease. However, this mutation can be beneficial in certain areas because it offers protection from malarial infections. This phenomenon can be used in a unit on genetics or evolution. Students can see how a single point mutation can lead to a misfolded protein which then leads to an inheritable disease.	Where is RNA Made? And Where Does It Go? Investigating Point Mutations **Explain** **Elaborate** The Central Dogma: How Your DNA Determines Who You Are The Making of the Fittest: Evolving Switches, Evolving Bodies (Stickleback) Part 1 The Making of the Fittest: Evolving Switches, Evolving Bodies (Stickleback) Part 2 The Making of the Fittest: Evolving Switches, Evolving Bodies (Stickleback) Part 3 HHMI Enrichment Video: Evolving Switches Student Quiz HHMI Enrichment Activity: Modeling the Regulatory Switches of Pitx1 **These activities will connect to ETS2.1 and ETS2.3* **Evaluate** **Textbook Materials**: Miller & Levine TN Biology **Ch. 13 DNA** Lesson 13.3 DNA Replication pgs. 424-427 **Ch. 14 RNA** Lesson 14.1 RNA pgs. 440-444 Lesson 14.2 Ribosomes and Protein Synthesis pgs. 445-450 Lesson 14.3 Gene Regulation and Expression pgs. 451-456 Lesson 14.4 Mutations pgs. 457-461 **Performance Task(s)** (Based on the Phenomenon): From Gene to Disease: Sickle Cell Anemia In this lesson, students learn about the relationships among environment, genotype, and phenotype. Through a case study approach, students learn about sickle cell anemia, a deadly recessive disease that remains prevalent in the human population because being a carrier of the disease confers resistance against malaria. Students explore the evolutionary trade-offs involved in this classic example of heterozygote

(replication origin, centromeres, and telomeres). In seventh grade, students discuss the passage of alleles from parent to offspring during sexual reproduction. Biology 1 should build on this understanding of genotypic and phenotypic relationships by establishing a connection between genotypes and the phenotypes resulting from expression of the genes. Specific examples such as pathways for melanin or lactase production can be used to relate monogenetic inheritance to phenotypes. In such pathways, students can demonstrate the role of various RNA types in the production of a protein through the processes of transcription and translation. The general idea that genes create proteins and that these proteins determine the function and appearance of cells and organisms has been established in 7.LS3. In BIO1.LS1.4 the mechanism by which proteins are produced from genes is explored. This standard is designed to complete the connection between genotypes, protein synthesis, and resulting phenotypes by examining concrete examples. It should become clear that recessive traits occur when neither diploid copy of a gene produces a functional protein. Students could research the cause of specific and relatively		advantage. Upon completion of this lesson, students will be able to: • Describe how a mutation at one point in the DNA can change an organism's phenotype. • Draw and interpret pedigree and Punnett square models. • Analyze data tables and maps to make and support claims. • Explain the principle of an evolutionary trade-off, and how environmental conditions influence fitness. **Additional Resources** 5E Plan – Molecular Genetics

simple examples of monogenic traits using a variety of level-appropriate resources (text, video, lecture, etc.) in order to elucidate the gene-protein-phenotype link. Classic examples could include but are not limited to: brown/blue base eye color due to melanin protein; PTC tasting due to a taste receptor on tongue cells; sickle cell anemia due to hemoglobin protein; PKU due to the enzyme that breaks down the amino acid phenylalanine; Hemophilia due to a clotting factor protein; ABO blood type due to an enzyme that attaches carbohydrates A, B, or nothing to the red blood cell. Students should recognize that phenotypic variation arises not only from genotypic variation, but also from gene expression variation, the latter of which can often be the result of environmental influences. For example: temperature regulates sex organ development in some fish species or fur color expression in some rabbit species; light regulates butterfly wing development; exercise increases muscle protein expression, isolation rearing in social animals alters brain gene expression; etc. **<u>Misconceptions</u>** • Most students believe that all mutations are bad, however, most		

mutations do not cause an issue with gene expression. Mutations are also neither good nor bad, it depends upon the environment that the organism is in. • Student believe the transcription/translation pathway can occur in any direction. According to The Central Dogma of DNA is that information can only flow from DNA to RNA to proteins. **<u>Science and Engineering Practice</u>** **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.* **<u>Cross Cutting Concept</u>** **Constructing Explanations** *Students form explanations that incorporate sources, (including models, peer-reviewed, their own investigations), invoke scientific theories, and evaluate the degree to which data and evidence support a given conclusion.*		

Biology Quarter 3 Curriculum Map				
Quarter 1	Quarter 2	**Quarter 3**	Quarter 4	
Unit 1 Cellular Structures & Energy Processes	Unit 2 Cell Division & Reproduction	**Unit 3** **Genetics**	Unit 4 Evolution	Unit 5 Ecology

9 weeks	9 Weeks	**9 Weeks**	3 Weeks	6 Weeks

Unit 3 Genetics [9 Weeks]

Overarching Question(s)

Why do individuals of the same species vary in how they look, function, and behave?

Unit, Lesson	Lesson Length	Essential Question	Vocabulary
Unit 3	2 Weeks	• What research efforts have resulted from the Human Genome Project? • How are transgenic organisms produced? • How can genetic engineering benefit agriculture and industry? • How can biotechnology improve human health? • How is DNA used to identify individuals? • To what extent and for what purpose should human genetically modify organisms?	Genome, Karyotype, Nondisjunction, Restriction Enzyme, Gel Electrophoresis, Genomic Imprinting, Selective Breeding, Biotechnology, Hybridization, Inbreeding, Polymerase Chain Reaction, recombinant DNA, plasmid, genetic marker, transgenic, clone, gene therapy, DNA microarray, DNA fingerprinting, forensics

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI(S) **BIO1.ETS2:** Links Among Engineering, Technology, Science and Society **Standard(s)** **BIO1.ETS2.1** Obtain, evaluate, and communicate information on how molecular biotechnology may be used in a variety of fields. **BIO1.ETS2.3** Analyze scientific and ethical arguments to support the pros and cons of application of a specific biotechnology technique such as stem cell usage, in vitro fertilization, or genetically modified organisms. **Explanation** The goal is to help students appreciate that the basic science knowledge being studied can be manipulated and used to design	**Learning Outcomes *(Possible Objectives)*** • Students can explain the importance of the Human Genome Project • Students can use a karyotype to explain chromosomal diseases • Students can justify their point of view on genetically engineered food • Students can identify the uses of various biotechnologies. **Phenomenon**  CRISPR: Gene Editing **Description**: CRISPR is a revolutionary gene-editing tool that can cut DNA with great precision, allowing genes to be turned off, new genes added or their functions changed. The gene editing technology is so powerful it could	**Curricular Resources** **Engage** Genetic Disorders Manipulating DNA Applying Biotechnology PCR Electrophoresis Gene Therapy Proteomics Zika and Genetically Modified Mosquitos Impact and Ethics of Biotechnology **Explore** DNA Sequencing DNA Profiling Genomic Sequencing Gel Electrophoresis Make a Karyotype Develop a Solution Lab Gel Electrophoresis Transforming an Animal Identifying Individuals Forensics Lab Using DNA to Solve Crimes **Explain**

useful tools for further scientific investigations, medical treatments, agricultural yields, etc. A detailed understanding of any technical procedures is not expected, but rather a "big picture" view of concepts the technology utilizes and the applications the technology is being used for. These technologies may be best investigated along with the standards from LS1 From Molecules to Organisms: Structure and Functions, as the students are learning about DNA and protein. Comparative DNA and protein sequence analysis is also a large part of current phylogenic research and could accompany LS4 Biological Change: Unity and Diversity. Students may also consider the pros and cons of biotechnical applications. Investigation of techniques utilized could come from field trips to witness the use of these techniques in practice, lab exercises, virtual labs, simulation activities, interviews with professionals, etc. Molecular techniques could include: PCR, electrophoresis, restriction enzyme digestion of DNA, DNA sequencing, plasmid-based transformation, transfection, etc. These techniques are used in fields of medicine, agriculture, biomedical engineering, forensic science, etc.	be used to wipe out entire species or solve long-standing agricultural problems, such as the annual culling of male chicks. **Interactive**: CRISPER-Cas 9 This interactive module explores how CRISPR-Cas9 technology works and the many ways in which scientists are using it in their research. Since it was first described in 2012, CRISPR-Cas9 (often shortened to "CRISPR") has generated much interest and excitement. This Click & Learn allows students to explore and learn about a biotechnology tool that is at the forefront of scientific research and hear directly from leading scientists about how they use CRISPR. The Click & Learn comprises a self-paced interactive animation and a series of short videos of various scientists who are using CRISPR-Cas9 technologies for basic research, medical, and agricultural applications. The "Web Assets" ZIP file contains the full animation and a set of related images and GIFs for use on social media, in the classroom, and for presentations to the public. **Article**: Issue Overview: Gene Editing or Gene Editing In the article Issue Overview: Gene Editing, the author states that humans have been manipulating genetics for thousands of years and then identifies the recent invention of Crispr-Cas9 (Crispr) technology and claims that this technology will greatly change genetic engineering in our world. Next, the article outlines some of the way's scientists are experimenting with Crispr technology and the possible outcomes. The author then provides a brief description of how Crispr works. Finally, the author mentions the opposing views on using Crispr on humans. **Video**: CRISPER Ethics CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats. It is an immune system in bacteria that has been co-opted by scientists to create a powerful DNA editing tool. It is a powerful tool that can be used in research and may eventually eliminate certain diseases. However, it also could allow humans to create designer babies and through the use of gene drives eliminate certain problem species (like mosquitoes) forever. CRISPR, as a new technology, can be used to give meaning to a unit on inheritance and variation	**Elaborate** Genetic Engineering Mosquitos Scientific articles counter common misconceptions on Internet condemning GMOs Gene Editing Wiped out a Population of Mosquitos Abnormal Chromosomal Inheritance Articles Combating Misconceptions about GMOs Genes Essential to Life Found in Mouse Mutants are Related to Many Human Disease Genes DNA Profiling Innocence Project Case Study DNA Profiling Switched at Birth Case Study plus Data **Evaluate** **Textbook Materials**: Miller & Levine TN Biology Ch. 15 The Human Genome Lesson 15.2: Human Genetic Disorders Lesson 15.3 Studying the Human Genome Ch. 16 Biotechnology Lesson 16.2 The Process of Genetic Engineering Lesson 16.3 Applications of Biotechnology Lesson 16.4 Ethics and Impacts of Biotechnology **Performance Task(s)** Students will be using the article *Lessons Overview: Gene Editing* as well as a few supporting texts to explain a real-world use of genetic engineering and explain the benefits and drawbacks of using this type of genetic manipulation. Students will focus on citing textual evidence from multiple relevant sources and then coherently presenting their findings. **Performance Task #2** Have students research one of the following Bioethical questions using credible sources and construct an argumentative essay describing both sides of the argument as well as their personal stance on the topic of choice. Bioethics Questions

The utilization of new technologies in any field of science is dependent on both economic and social factors. In addition to evaluating these factors, scientists must also consider long-term consequences that may not be initially apparent. The emphasis should be on the construction of a rationale argument that supports a position on the use of an application with ethical and social impact. Students should begin to appreciate the differences in ethical values that exist and recognize that discussion of these values is imperative as knowledge and technology continue to advance, even when resolutions of differences can be rare. After investigation of a specific biotechnology application, students can write a position paper and/or participate in a classroom debate. **<u>Misconceptions</u>** • Students believe that genetically modified means mutant or harmful. Genetically modified means that the genes have been altered. **<u>Connections to Technology:</u>**		1. Should the government have a say in the genetic mutations that patients choose to allow to persist in a community? 2. Is water a commodity or a resource? 3. Should vaccines be mandatory for children to enter public school? 4. Does the government have the responsibility to respond to the threat of climate change? 5. Does a person with a terminal disease have the right to physician-assisted suicide? 6. Should companies be required to put GMO labels on products made for human consumption? 7. Is addiction a mental health issue or a criminal issue? 8. Should parents have the right to select specific traits in their offspring (designer babies)? 9. If a person discovers a gene mutation that causes a disease, do they have the right to patent the gene? 10. Is it ethical to require medications to be tested on multiple animal models prior to human trials? 11. Should oil drilling and exploration be allowed in protected land and water areas? 12. What is the ethical line in stem cell research? **<u>Performance Task #3</u>** **STEM PROJECT:** **<u>Design Evaluation Criteria for Uses of GM Animals</u>** In this project, students will work in groups to design a proposed set of criteria for evaluating three specific uses of GM animals. Students will choose the criteria that make the most sense then design a survey for other students or community members that uses a rubric with those criteria. Students will develop a graphical representation of the survey data. Students will then revaluate and redesign the list of criteria that they initially proposed. **Related SEPs**: • Asking Questions and Designing Solutions • Obtaining, Evaluating, and Communicating Information • Engaging in Argument from Evidence **<u>Additional Resources</u>**

Students become aware of genetic engineering as well as the problems it can help solve. Students discover that many food, plants and medicines have been and continue to be created using genetic engineering. **<u>Science and Engineering Practice</u>** ***Analyzing and interpreting data.*** *Students should derive proportionalities and equalities for dependent variables which include multiple independent variables, considering uncertainty, and limitations of collected data.* **<u>Cross Cutting Concept</u>** ***Pattern*** *Students recognize, classify, and record patterns in quantitative data from empirical research and mathematical representations*		5E Plan - Biotechnology

Curriculum and Instruction- Science			
RESOURCE TOOLKIT			
Quarter 3		Biology	
Textbook Resources Pearson Realize Miller & Levine TN Biology	**DCIs and Standards** **DCI** **BIO1.LS1**: From Molecules to Organisms: Structures and Processes **BIO1.LS3**: Heredity **BIO1.ETS2**: Links Among Engineering, Technology, Science and Society **Standard(s)** BIO1.LS3.3 BIO1.LS1.3 BIO1.LS1.4 BIO1.LS3.2 BIO1.ETS2.2 BIO1.LS3.1 BIO1.LS1.1	**Websites/Videos** Muscle Fibers Genetically Modified Organisms Genome Editing with CRISPR-Cas9 Genetic Engineering Will Change Everything Forever – CRISPR How To Eradicate One Of Our Deadliest Enemies – Gene Drive & Malaria What If We Killed All the Mosquitoes? CRISPR: A Gene-Editing Superpower Why are GMOs Bad? Resurrection Biology: How to Bring Animals Back From Extinction	**ACT & SAT** TN ACT Information & Resources SAT Connections SAT Practice from Khan Academy Khan Academy Illuminations (NCTM) Discovery Education The Futures Channel The Teaching Channel Teachertube.com