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

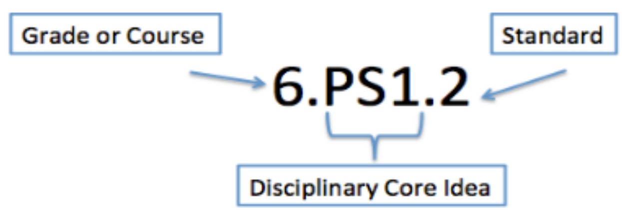
Learning ProgressionAt the end of the elementary science experience, students can observe and measure phenomena using appropriate tools. They are able to organize objects and ideas into broad concepts first by single properties and later by multiple properties. They can create and interpret graphs and 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 4 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 4- Evolution [3 Weeks]

Overarching Question(s)

How can there be so many similarities among organisms yet so many different kinds of plants, animals, and microorganisms?
How does biodiversity affect humans?

Unit, Lesson	Lesson Length	Essential Question	Vocabulary
Unit 4	3 Weeks	LS4.1 • How does the scientific data support the theory of evolution? • What are the advantages and disadvantages of asexual reproduction? • What are the advantages and disadvantages of sexual reproduction? LS 4.2 • How do allelic frequencies change? • What causes natural selection?	LS4.1 Evolution, Fossil, Artificial Selection, Adaptation, Fitness, Natural Selection, Biogeography, Homologous Structure, analogous Structure, Vestigial Structure LS4.2 Gene pool, allele frequency, single-gene trait, polygenic trait, directional selection, stabilizing selection, disruptive selection, genetic drift, bottleneck effect, founder effect, genetic equilibrium, sexual selection, gene flow, speciation, reproductive isolation, behavioral isolation, geographical isolation, temporal isolation

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI *BIO1.LS4: Biological Change: Unity and Diversity* ***Standard*** BIO1.LS4.1 Evaluate scientific data collected from analysis of molecular sequences, fossil records, biogeography, and embryology. Identify chronological patterns of change and communicate that biological evolution is supported by multiple	**Phenomenon** Antibiotic resistant bacteria [New York Times Article]	**Lessons** **Lesson 1: Evidence of Evolution** **Days: 1-4** **SEP: Engaging in an Argument from Evidence** **CCC: Stability and Change** **Textbook Materials** Miller and Levin Chapter 17

lines of empirical evidence that identify similarities inherited from a common ancestor (homologies). Compare and contrast the processes of sexual and asexual reproduction, identifying the advantages and disadvantages of each. BIO1.LS4.2 Using a model that demonstrates the change in allele frequencies resulting in evolution of a population over many generations, identify causative agents of change. ***<u>Explanation</u>*** LS4.1 In earlier grades, students have discussed the origin of fossils, the fossil record, and comparative anatomy. BIO1.LS3 delves into the molecular basis for the phenotype of an organism. That new understanding provides a foundation for discussions about the significance of similarities between the genomes of extinct and extant organisms. Similarities in genomes provide a rationale for common amino acid sequences. Well documented examples for data analysis could include but are not limited to the following: Molecular data demonstrating that all life shares the same genetic code; comparative DNA and protein sequence data demonstrating conservation of ubiquitous genes/proteins such as ribosomal protein, cytochrome c, etc.; fossil records demonstrating that major life forms currently on earth were not present in the past and major past life forms are not currently present; transitional fossil records that demonstrate anatomical changes over time showing radiation from fish to tetrapods, reptile (dinosaur) to birds, synapsids to mammals, land mammals to aquatic mammals, horse lineage, etc.; biogeographical data demonstrating that species in close geographical proximity (regardless of habitat	The Atlantic ~ Antimicrobial Resistance Superbugs Antibiotic resistance is an example of evolution that we can see in real time. LS4.2 **<u>Learning Outcomes</u>** • Students can identify and model the multiple mechanisms of evolution through allelic change • Students can predict the outcome of a change in allelic frequencies **<u>Phenomenon</u>** Rock Pocket Mouse The rock pocket mouse population changed their genetic make-up when there was a volcanic explosion, and they were exposed on the black	Teacher Resources Biointeractive Evolution course Evolution 101 Evolution Handouts and Activities **Laboratory Activities/Investigations** Evidence for Evolution Natural Selection and Darwin Lizard evolution lab Evidence of Evolution Lab p. 565 **Simulations** **Stickleback Video and Quiz** **Articles** Misconceptions of Evolution **Hybrids** **Lesson 2: Creating and interpreting Phylogenetic Trees** **Days 5-8** **SEP: Engaging in an Argument from Evidence** **CCC: Patterns** **Laboratory Activities/Investigations** NOVA Evolution Lab Phylogeny Data Sets **Lesson 3: Interpreting Reproductive Strategies** **Days 9-10** **SEP: Engaging in an Argument from Evidence** **CCC: Stability and Change** **Simulations** **Sexual vs. Asexual Reproduction** **Learn Genetics Reproduction**

differences) resemble more than species in more similar habitats of distant proximity such as the Galapagos island species that most closely resemble their nearest neighbors in South America; embryological data demonstrating shared anatomical structures among the embryos of organism groups such as gill slits and tail display in all vertebrate embryos. ***<u>Misconceptions</u>*** • Humans came from monkeys ~ Humans and monkeys share a common ancestor • Evolution is just a "theory" ~ Theory in science • Individuals can evolve ~ Evolution is change over time and the mechanisms of evolution • Evolution takes a long time ~ Evolution can occur over a short time span in terms of a few generations. ***<u>Explanation</u> LS4.2*** Requirements for natural selection (variation, inheritance and competition) should be recognized that with each generation there are random modifications, only some of which may enhance reproductive success within the given environment, allowing for persistence into the next generation. Repetition of this process over many generations leads to the non-random accumulation of adaptive traits in a given environmental setting. Students should investigate the mechanism by which isolation (reproductive isolation, geographical isolation, temporal isolation) can lead to evolutionary change. Other agents of change may include genetic drift (population bottlenecks, founder effect and sampling error). Predict observations that would be observed in accordance with this phenomenon. A simulation could be used that exhibits random variation		**Articles** Lichen Changes Reproductive Strategies **Performance Tasks** Case Study pg. 568 Performance-Based Assessment pg. 572 **Lessons** **Lesson 1: Mechanisms of Allele Frequency Change** **Days 1-5** **SEP: Developing and Using Models** **CCC: Structure and Function** **Textbook Materials** Miller and Levin Chapter 18 **Simulations** Mechanisms of Evolution Webquest Survival of the Fittest Game Natural Selection PhET Genetic Drift **Lesson 2: Tracking Allele Frequency Change** **Days 6-10** **SEP: Developing and Using Models** **CCC: Structure and Function** **Laboratory Activities/Investigations** Allele Frequency Lab Hardy-Weinberg Equilibrium **Simulations** PopGen Simulator Rock Pocket Mouse Genotype Analysis

introductions through mutations or gene flow and genetically-based trait transmission through generations in order to investigate causative agents of change such as a natural disaster or isolation that results in random modification of the population (genetic drift) or altered climate, resources, competitors, etc. that result in nonrandom accumulation of adaptive traits (natural selection). Students can analyze a variety of common examples of adaptations such as bird beak adaptations, insect mimicry, antibacterial-resistant strains of bacteria, etc. and explain the factors that led to an accumulation of a particular trait in a population. This explanation can be extended to also explain how natural selection mechanisms can result in the observation of non-beneficial traits such as species overspecialization (i.e. the cheetah, panda bear, koala) that increases probability of going extinct, suboptimal traits (i.e. vertebrate eye structure that causes blind spots), or vestigial traits (i.e. eye structures in cave fish). (Hardy-Weinberg equation may be used for enrichment, but is beyond the scope of BIO1.) ***Misconceptions*** **Just because a trait is dominant, that means that it is present more often ~ Traits are present based on the current fitness of the organism** **Science and Engineering Practice** Engaging in Argument form 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** Stability and Change Students provide examples and explanations for sudden and gradual changes		**Performance Tasks** Performance-Based Assessment pg. 604 Students should research the following genetic mutations that has persisted in the human population, even though being homozygous for the mutation leads to disease. Sickle Cell Lactose Tolerance Hypoxia tolerance Then students should write a Claim-Evidence-Reasoning essay about human genetic evolution Paragraph 1 Introduction/Hook What is natural selection? How is natural selection a mechanism of evolution? State claim Introduce evidence Paragraph 2 First adaptation Describe first adaptation Reasoning: How has this adaptation allowed human populations to survive? Paragraph 2 Second adaptation Describe first adaptation Reasoning: How has this adaptation allowed human populations to survive? Paragraph 3 Third adaptation Describe third adaptation

		Reasoning: How has this adaptation allowed human populations to survive? Paragraph 4 Recap evidence Recap reasoning Concluding sentence What have you learned from this lesson? What do you think requires further research? Final thoughts...LS4.2

Biology Quarter 4 Curriculum Map				
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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	9 Weeks	9 Weeks	**3 Weeks**	6 Weeks

Unit 5- Ecology [6 Weeks]			
Overarching Question(s)			
What evidence shows that different species are related?			
Unit, Lesson	**Lesson Length**	**Essential Question**	**Vocabulary**
Unit 5	6 Weeks	**Essential Questions** • How does biomass change at each trophic level? • How do the laws of conservation of energy and conservation of mass explain the variations in biomass between trophic levels? • How can we model the variations in biomass and energy between trophic levels?	Evolution, Fossil, Artificial Selection, Adaptation, Fitness, Natural Selection, Biogeography, Homologous Structure, analogous Structure, Vestigial Structure

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI BIO1.LS2: Ecosystems: Interactions, Energy, and Dynamics **Standard** BIO1.LS2.4 Analyze data demonstrating the decrease in biomass observed in each successive trophic level. Construct an explanation considering the laws of conservation of energy and matter and represent this phenomenon in a mathematical model to	**Learning Outcomes** • Students can predict what trophic level an organism belongs in based on its dietary needs • Students can use food webs and pyramids to explain the laws of conservation of energy and mass • Students can use mathematical modeling to predict how much energy will be found at each level of a trophic cascade	**Lessons** **Lesson 1: Biomass and Trophic Level** **Days: 1-2** **SEP: Constructing Explanations and Designing Solutions** **CCC: Patterns** **Textbook Materials** Miller and Levin Chapter 4.1 ~ Energy, Producers, and Consumers Chapter 4.2 ~ Energy Flow in Ecosystems **Laboratory Activities/Investigations**

describe the transfer of energy and matter between trophic levels. **Explanation** It should be appreciated that matter and energy are not destroyed/lost as they transfer between trophic levels. The laws of conservation are supported as organic matter and its chemical energy is transferred into inorganic matter and heat energy through respiration and decomposition. In addition, it should be recognized that energy transfer is inefficient with loss of approximately 90% at each trophic level transfer. Any set(s) of population data from an ecosystem that clearly shows the mass of all organisms represented at primary, secondary, tertiary, etc. trophic levels can be utilized to examine the phenomenon and ask probing questions of why and how. Considering the laws of conservation of energy and matter, an explanation should strive to explain how and where energy and matter transfer from the organic pools in each trophic level. A model should illustrate the "10% rule" of energy transfer and can be displayed in a pyramid model and/or simulation activity. **Misconceptions** • Food webs/food chains have a start and an end ~ Food chains are used to represent the interactions between organisms. 25% of school aged children believe that animals exist on the sole basis for human benefits. The food pyramid depicts how children may see the flow of food chains as direct from bottom (producers) to the top (predator). Students need to be able to see the food	**Phenomenon** DDT and the Food Web	Building Ecological Pyramids **Building Food Webs** **Lesson 2: Mathematical Models of Energy and Matter Transfer** **Days 3-5** **SEP: Using Mathematics and Computational Thinking** **CCC: Patterns** **Simulations** Ecology Trophic Levels Simulation Exploring Trophic Cascades **Laboratory Activities/Investigations** Energy Pyramid Biomass Pyramids **Articles** Species Rich Food Webs **Performance Tasks** Creation of a food web Use the online platform Ecology Lab to use Claim-Evidence-Reasoning to answer the following question. "How does food web complexity affect the biodiversity of an ecosystem?"

chains a cycling process where the Predator then decompose and are included in the transferring of energy (food) to the producers to start the chain again. There needs to also be a direct link of food chains and food webs and how they can be altered due to external factors (what happens if secondary consumers population increased? or how does human activity affect the food chain?). • An animal high in the food web is a predator for all of the lower organisms ~ The higher organisms are predators for some organism below them, but they rely on the interactions between lower organisms within the food chain. ***Science and Engineering Practice*** Constructing explanations and designing solutions Students form explanations that incorporate sources (including models, peer reviewed publications, their own investigations), invoke scientific theories, and can evaluate the degree to which data and evidence support a given conclusion**.** ***Cross Cutting Concepts*** Patterns Students recognize, classify, and record patterns in quantitative data from empirical research and mathematical representations.		

DCI BIO1.LS2 *BIO1.LS4: Biological Change: Unity and Diversity*	Textbook Resources	Websites/Videos	ACT & SAT
Standard BIO1.LS4.1 BIO1.LS4.2 BIO1.LS2.4	5E Lesson Resource Link	Sickle Cell Lactose Tolerance Hypoxia tolerance Evidence for Evolution Natural Selection and Darwin Lizard evolution lab Ecology Trophic Levels Simulation Exploring Trophic Cascades	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