# Rutherford County Schools

# 7th Grade Science Curriculum Guide

# 2023-2024

# Disciplinary Core Ideas

## Life Science

### From molecules to organisms: Structures and processes

LS1.A: Structure and function
LS1.B: Growth and development of organisms
LS1.C: Organization for matter & energy flow in organisms
LS1.D: Information processing

### Ecosystems: Interactions, energy, and dynamics

LS2.A: Interdependent relationships in ecosystems
LS2.B: Cycles of matter and energy transfer in ecosystems
LS2.C: Ecosystem dynamics, functioning, and resilience
LS2.D: Social interactions and group behavior

### Heredity: Inheritance and variation of traits

LS3.A: Inheritance of traits
LS3.B: Variation of traits

### Biological change: Unity and diversity

LS4.A: Evidence of common ancestry
LS4.B: Natural selection
LS4.C: Adaptation
LS4.D: Biodiversity and humans

## Earth & Space Science

### Earth's place in the universe

ESS1.A: The universe and its stars
ESS1.B: Earth and the solar system
ESS1.C: The history of planet Earth

### Earth's systems

ESS2.A: Earth materials and systems
ESS2.B: Plate tectonics and large-scale system interactions
ESS2.C: The roles of water in Earth's surface processes
ESS2.D: Weather and climate
ESS2.E: Biogeology

### Earth and human activity

ESS3.A: Natural resources
ESS3.B: Natural hazards
ESS3.C: Human impacts on Earth systems
ESS3.D: Global climate change

## Physical Science

### Matter and its interactions

PS1.A: Structure and properties of matter
PS1.B: Chemical processes
PS1.C: Nuclear processes

### Motion and stability: Forces and interactions

PS2.A: Forces, fields, and motion
PS2.B: Types of interactions
PS2.C: Stability and instability in physical systems

### Energy

PS3.A: Definitions of energy
PS3.B: Conservation of energy and energy transfer
PS3.C: Relationship between energy and forces & fields
PS3.D: Energy in chemical processes and everyday life

### Waves and their applications in technologies for information transfer

PS4.A: Wave properties
PS4.B: Electromagnetic radiation
PS4.C: Information technologies and instrumentation

## Engineering, Technology, and the Application of Science

ETS1: Engineering design
ETS2: Links among engineering, technology, science, and society
ETS3: Applications of science

# Science and Engineering Practices

## Asking questions and defining problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested.

## Developing and using models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

## Planning and carrying out investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

## Analyzing and interpreting data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results.

## Using mathematics and computational thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships.

## Constructing explanations and designing solutions

The end-products of science are explanations and the end-products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.

## Engaging in argument from evidence

Argumentation is the process by which evidence-based conclusions and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem.

## Obtaining, evaluating, and communicating information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

# Crosscutting Concepts

## Patterns

Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

## Cause and effect

Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

## Scale, proportion, and quantity

In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

## Systems and system models

A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

## Energy and matter

Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

## Structure and function

The way an object is shaped or structured determines many of its properties and functions.

## Stability and change

For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

# RCS Science Instructional Model

## Overview

A high-quality science unit is defined as a science content storyline—the sequence of main learning goals across lessons and the sequence of science ideas within lessons. ***Thoughtful sequencing of main learning goals and science ideas along with matched activities/investigations is critical to planning coherent science content storylines for students and to the students' ability to construct the storyline for themselves and make sense of the anchoring phenomenon.***

## Storyline Components

**Anchoring Phenomenon:** An anchoring phenomenon connects all student learning and science ideas within a unit; it is a naturally occurring event that the students are trying to make sense of throughout the unit.

**Unit Learning Goal:** A unit learning goal is the big science idea (disciplinary core idea—DCI) that students are expected to learn and take away from the unit; the unit learning goal shows the relationship among science ideas that can be used to explain multiple phenomena; serves to organize supporting science ideas, activities/investigations, and vocabulary; ***the unit goal is teacher facing***.

**Unit Driving Question:** The Unit Driving Question should be related to the anchoring phenomenon and gives students a purpose what they are learning throughout the unit; the Unit Driving Question is developed by the class by using questions from the Driving Question Board; students will work to answer this question by the end of the unit.

**Unit Activities/Investigations:** Keep in mind that the activities and investigations you choose to for the unit need to be ***closely matched*** to the unit learning goal and the lesson main learning goal with a focus on the 3-dimensions of the TN Academic Standards—***Disciplinary Core Ideas*** (DCIs), ***Science & Engineering Practices*** (SEPs), and ***Crosscutting Concepts*** (CCCs).

# Lesson Framework

**Lesson Main Learning Goal:** *To identify the complete science concept you want students to learn (for teacher)*

- The lesson main learning goals has the same requirements of the unit learning goal; the lesson main learning goal also focuses attention on how the science ideas in a lesson are sequenced and linked to one another and to lesson activities/investigations to help students construct a coherent ***story*** that makes sense to them.*
  **The first step in creating a coherent science content storyline in a series of lessons is to identify the main learning goal of the lesson—**what big idea do you want students to learn in this lesson?***

**Lesson Focus Question:** *To provide a focus for the lesson that keeps attention on main learning goal (for students);* each lesson in the unit will have its own focus question that will be introduced at the beginning and highlighted throughout

- A focus question sets the purpose for the lesson (or series of lessons) by focusing students' attention on the intended learning goal for the lesson; while the main learning goal for the lesson is teacher facing, the focus question is student facing, but should closely match the main learning goal and be in a language students understand. Ideal uses of the focus question are to:
  - elicit students' initial ideas at the beginning of a lesson,
  - engage students' interest in the science content of the lesson,
  - serve as an organizer throughout the lesson, and
  - bring closure to the storyline at the end of the lesson.

**Link Science Ideas:** To make the science content storyline visible to students and engage students in thinking about science ideas related to the anchoring phenomenon and activities/investigations, you should:

- make explicit links between science ideas and activities (before, during, and after each activity/investigation)
- link science ideas to other science ideas
    - Before lesson: link to ideas from previous lessons
    - During lesson: as appropriate
    - End: link ideas developed during lesson and in previous lessons; foreshadow next lesson
- highlight key science ideas and focus question throughout—multiple times throughout lesson
- make key science ideas visible by keeping track of them on an Idea Tracker, a poster/chart paper that stays hanging in the classroom

| Idea Tracker | |
|---|---|
| Focus Question | What we figured out… |
| | |

**Set-up for Activity/Investigation**

- The purpose of the activity as it relates to the main learning goal and to the developing storyline.
- Set-up for the activity makes explicit links to science ideas.
- Students should be required to think or make predictions about their ideas related to the learning goal before they being the activity/investigation.

**Activity/Investigation**

- Activities/investigations are designed so so that it requires students to make links between the activity/investigation and the science ideas and use specific SEPs & CCCs throughout.

**Follow-up to Activity/Investigation**

- Follow up the activity/investigation by focusing on linking the activity with science ideas and the science content storyline.

**Activities/investigations should *ALWAYS* be matched to the main learning goal and connect back to the anchoring phenomenon!** There may be one or more than one activity or investigation in each lesson. If there is more than one, you will always do the set-up, activity, and follow-up for each activity or investigation and number them. For example, Set-up for Activity 1, Activity 1, and Follow-up to Activity 1. One important aspect of the activities/investigations is to provide opportunities of content representations and models matched to the learning goal.

**Synthesize and Summarize:** *The science content storyline needs to be tied together at the end of the lesson*

- A summary statement is one way to make connections between science ideas or between science ideas and activities/investigations addressed in the lesson and to highlight how they support the main learning goal of the lesson and the anchoring phenomenon.
- Give students the opportunity to revisit the Driving Question Board and revise their initial claim and model to help make sense of the anchoring phenomenon, as well as the class consensus model.

## Day 1

*The structure of Day 1 is a little different than the remaining days in the unit because it sets the stage and purpose fort the ENTIRE unit.*

**Lesson Main Learning Goal:** *To identify the complete science concept you want students to learn (for teacher)*

- The lesson main learning goals has the same requirements of the unit learning goal; the lesson main learning goal also focuses attention on how the science ideas in a lesson are sequenced and linked to one another and to lesson activities/investigations to help students construct a coherent ***story*** that makes sense to them.*

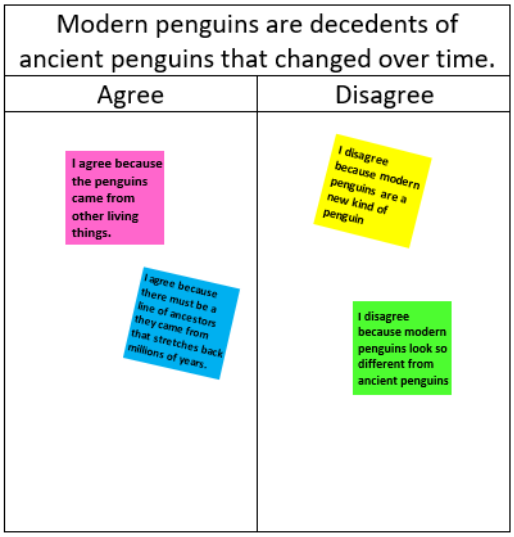
  **The first step in creating a coherent science content storyline in a series of lessons is to identify the main learning goal of the lesson—**__what big idea do you want students to learn in this lesson?__

**Introduction:**

- Introduce anchoring phenomenon
- Allow students to make observations and ask questions about the phenomenon
- In small groups, students will share their questions and develop one question for their group and record it in their notebooks; the group question and all other questions will be displayed on the Driving Question Board in clusters by similarity.


**Unit Driving Question:** *Here the Unit Driving Question is established instead of the lesson focus question.*

- Based on group questions, the class will develop a driving question that they will work towards answering to make sense of the phenomenon.
- Elicit student ideas about the driving question by having students develop an initial model and claim.




**Set-up for Activity:**

- Review the driving question.
- In small groups, have students discuss their initial models and claims and write their initial science ideas (including misconceptions) on multiple agree/disagree charts—one idea per chart.

**Activity:**

- Have students add sticky notes to the T-charts justifying why they agree or disagree. (Their justifications will first come from personal experience since content has not been taught yet.)
- Students can add stickies with evidence on them to the "Agree" or "Disagree" side of each claim, throughout the unit. You can use different colors of stickies for each source of evidence (e.g., Experiment-pink, Personal experience-green, Video-blue...).

**Follow-up to Activity:**

- Students share ideas about the claims and relate their ideas to the driving question.
- As a class, work together to develop a class consensus model, starting with the initial model students developed on their own.

**Summarize/Synthesize:**

- Students summarize one or more claims (science ideas) they agree with and why, as well as one or more they may disagree with and why.

**Link to Next Lesson:**

- Teacher links anchoring phenomenon, driving question, and science ideas/claims to next lesson.

Credits:
https://ambitiousscienceteaching.org/
https://bscs.org/

RCS 7th Grade Science Curriculum Guide

**Table of Contents:**

RCS 7th Grade Science Curriculum Guide

**Pacing Guide: *Essential Standards are bolded and highlighted in yellow.***

| Grading Period | Standards |
|---|---|
| **Q1**<br>37 Instructional Days<br><br>7.PS1.6<br>August 14-17<br><br>**Storyline**<br>*Bath Bombs*[1]<br>August 18-September 29 | Classroom Procedures, Get-To-Know-You Activities, Introduce phenomena and the three dimensions (SEPs, CCCS, & DCIs) with a focus on Scientific Modeling |
| | 7.PS1.6 States of matter with respect to temperature and pressure |
| | 7.PS1.3 Composition of matter (pure substances or mixtures)[1] |
| | 7.PS1.5 Periodic Table Trends—physical and chemical properties[1] |
| | 7.PS1.1 Structure of atoms[1] |
| | **7.PS1.2 Elemental and compound molecules[1]** |
| | **7.PS1.4 Chemical reactions/Law of Conservation of Mass[1]** |

| Grading Period | Standards |
|---|---|
| **Q2**<br>44 Instructional Days*<br><br>**Storyline**<br>*A Medical Mystery*[2]<br>October 9-December 19 | **7.LS1.5 Body systems (processes and interactions) [2]** |
| | 7.LS1.4 Levels of organization from cell to organism[2] |
| | **7.LS1.1 Structure and function of cell organelles[2]** |
| | 7.LS1.2 Cell membrane and passive transport[2] |
| | **7.LS1.9 Photosynthesis and cellular respiration—cycling of matter and flow of energy[2]** |
| | 7.ETS2.1 Bioengineering solution/biomaterials[2] |

| Grading Period | Standards |
|---|---|
| **Q3 & Q4**<br>49 Instructional Days*<br><br>7.LS1.3<br>January 8-12<br><br>**Storyline**<br>*Superhero Origin Stories*[3]<br>January 16-March 7<br><br>7.LS2.1<br>7.ESS3.1<br>7.ESS3.2<br>March 8-22 | 7.LS1.3 Comparing cells across kingdoms |
| | 7.LS1.7 Sexual and asexual reproduction[3] |
| | 7.LS3.2 Mitosis vs. meiosis[3] |
| | 7.LS1.8 Growth and development (mitosis) [3] |
| | 7.LS3.3 Genetic probability (ratios/Punnett squares) [3] |
| | 7.LS3.1 Variation of traits[3] |
| | 7.LS1.6 Behavioral and structural adaptations[3] |
| | 7.LS2.1 Cycles of matter and energy transfer in ecosystems (carbon and oxygen) |
| | 7.ESS3.1 Composition of the atmosphere |
| | 7.ESS3.2 Human activity and climate change |

| Grading Period | Standards |
|---|---|
| **Q4** | Review Testing April 1-12 (based on preliminary TCAP dates) |
| | State Testing April 15-May 3 (preliminary dates) |
| | STEM Investigations/End-of-Year Activities |

*Two instructional days were subtracted for district benchmark testing.

| 7.PS1.1 | Develop and use models to illustrate the structure of atoms, including the subatomic particles with their relative positions and charges. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

Models should include a nucleus containing positively charged protons and neutrons without charge. Students should recognize that electrons are located outside of the nucleus but are not responsible for creating models for the distribution of all electrons, nor are they expected to list full configurations for electrons. These ideas may still be desirable to lead students to an understanding of valence electrons. Students should see the relationship between the number of valence electrons possessed by an element and its location on the periodic table.

Student should connect the components of their models (protons, neutrons, electrons) to arrangement of the periodic table. Models including locations and charges of subatomic particles are sufficient to explain relative sizes of atoms (the force of protons on electrons). These same discussions of atomic radius can extend into the general electronegativity trends, arising from repulsion of electrons as they are condensed in smaller radii. The idea of high electronegativity combining with low electronegativity will support patterns observable in way elements combine on the periodic table (7.PS1.5).

*(Discussions of valence electrons should be limited to elements with only one common oxidation state, and only those with valence electrons in S and P orbitals.)*

**Learning Targets - DCIs**
*Matter and Its Interactions*

1. Atoms are the smallest unit of matter and they have a nucleus of positively charged protons and neutrons without a charge surrounded by negatively charged electrons.
2. Using the periodic table to identify the number of subatomic particles in an atom (protons = atomic number, electrons = protons, neutrons = atomic mass – atomic number).
3. Valence electrons are located in the outer shell of an electron and the number of valence electrons effect the element's location on the periodic table, reactivity, electronegativity, and many other properties of an element.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Develop a model of an atom to show the relative position and charges of the subatomic particles (structure and function).
2. Using information from the Periodic Table, identify the structure and function of the subatomic particles of a given element (analyzing and Interpreting data).
3. Construct an explanation of the relationship between an element's location on the periodic table to its valence electrons, reactivity, and electronegativity (patterns).

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

| Anchoring: | Investigative: |
|---|---|
| • When solid bath bombs are added to water, they start breaking apart, and gas bubbles appear on and around them for a few minutes, until no solid is left.<br>• Ancient Egyptians used copper vessels to keep water fresh and safe to drink.<br>**This blog is for teacher information.* | • There is lightning during a rainstorm.<br>• When a balloon is rubbed on a person's head their hair stands up.<br>• A PVC pipe can make an orb levitate. |

**Lesson Resources**

- ***UPDATED!*** Bath Bombs Teacher Guide (storyline unit goes with bath bombs anchoring phenomenon and standards 7.PS1.1-1.5)
  - Bath Bomb folder
- Lesson from TDOE: Developing and using models (lesson goes with balloon or copper anchoring phenomenon)
- Make a Levitating Orb (investigation goes with tinsel orb anchoring phenomenon)
- Parts of an Atom Challenge (lesson goes with tinsel orb anchoring phenomenon)

- Atoms Lesson Plan (5E lesson)
- Nearpod: Structure of an Atom
- Wonderopolis: What is Inside an Atom?
- PhET: Build an Atom (simulation)
- cK-12: Atom Builder (simulation)
- Atomic Structure and Electrons—Structure of An Atom (video)
- TED-Ed: Just How Small is an Atom? (video)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE Volume 1: 14-16; 19A-G; 36-39; 76-89H; 90-120; 121-125<br>SE: 14-16; 36-39; 76-89; 90-120; 121-125 | 5.PS1.1 Analyze and interpret data from observations and measurements of the physical properties of matter to explain phase changes between a solid, liquid, or gas.<br><br>5.PS1.4 Evaluate the results of an experiment to determine whether the mixing of two or more substances result in a change of properties. |

**Content to Explore**

| | |
|---|---|
| atom | subatomic particles |
| protons | neutrons |
| electrons | valence electrons |
| periodic table | reactivity |
| electronegativity | |

| 7.PS1.2 | Compare and contrast elemental molecules and compound molecules. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

The word "molecule" is often over-generalized to describe a single particle of any compound. Only some substances (either elements or compounds) exhibit molecular behavior, and only those substances are referred to as molecules. Examples of molecular behaviors include low melting and boiling points, poor conductivity, and pliability.

The atoms bonded in a molecule are connected internally by a sharing of electrons. Molecular compounds are also described as covalent compounds because of this behavior.

Students should see that some single elements exist in a molecular form, with more than one atom bonded together in a pure form. The noble gases also exhibit molecular behavior, but in a monoatomic form. Students should also be able to differentiate between molecules of a diatomic element and compound molecules.

**Learning Targets - DCIs**
*Matter and Its Interactions*

1. Monoatomic elements consist of only one atom while elemental molecules are two or more of the same type of atoms bonded together.
2. Diatomic elements or molecules are two of the same atoms bonded together.
3. Compound molecules are two or more different types of atoms bonded together.
4. Molecules are groups of atoms bonded together by ionic (transferring electrons) or covalent (sharing electrons) bonds.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Engage in argument providing evidence to show the structure of monoatomic elements and elemental molecules.
2. Develop a model of a diatomic molecule showing the quantity and type of atoms required.
3. Construct an explanation on the quantity and type of atoms needed for a molecule to be classified as a compound molecule.
4. Using patterns on the periodic table, develop questions to distinguish between the types of bond that created a given molecule.

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

Anchoring:

- When solid bath bombs are added to water, they start breaking apart, and gas bubbles appear on and around them for a few minutes, until no solid is left.
- Macaroni salad and gasoline are made of the same stuff.
- The difference between CO and $CO_2$ is one oxygen atom, which is the difference between life and death.

Investigative:

- As the ocean absorbs carbon dioxide from the atmosphere, it is becoming more acidic.
- When dish soap is added to a plate of milk with drops food coloring in the center, the colors quickly disperse across the surface.
- When the outside rind of an orange is squeezed over a balloon, the balloon pops.
- Water smells good, but when I add ammonia to water it smells bad.

**Lesson Resources**

- ***UPDATED!*** Bath Bombs Teacher Guide (storyline unit goes with bath bombs anchoring phenomenon and standards 7.PS1.1-1.5)
  - Bath Bomb folder
- Ocean Acidification (performance task goes with ocean anchoring phenomenon)
- CO vs $CO_2$ (performance assessment goes with CO/$CO_2$ anchoring phenomenon)
- Wonderopolis: Why Do Atoms Form Molecules?

- Molecules Matter (5E lesson)
- PhET: Build a Molecule (colorado.edu) (simulation)
- Marshmallow Molecules
- The Structure of Molecules (GRC lesson goes with water investigative phenomenon)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE Volume 1: 14-17; 19A-G; 36-39; 98-105H; 106-113H; 120-123; 188-193H<br>SE: 14-17; 36-39; 98-105; 106-113; 120-123; 188-193 | 5.PS1.3 Design a process to measure how different variables (temperature, particle size, stirring) affect the rate of dissolving solids into liquids.<br><br>5.PS1.4 Evaluate the results of an experiment to determine whether the mixing of two or more substances result in a change of properties. |

**Content to Explore**

| | |
|---|---|
| atoms | molecules |
| elemental molecules | compound molecules |
| ionic bonds | covalent bonds |
| monoatomic elements | diatomic elements |

| 7.PS1.3 | Classify matter as pure substances or mixtures based on composition. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

Pure substances have a single chemical composition and a single set of physical and chemical properties. These chemical and properties can be used to identify a pure substance (7.PS1.5). When a pair of pure substances are mixed, one of two outcomes is possible: the two substances do not interact, and the outcome is a mixture, or the two substances do interact, resulting in a new substance with new physical properties. In a mixture, each of the components of the mixture will retain its physical properties. This allows for separation of mixtures based on physical properties.

Students should track physical properties use physical properties to substantiate the classification of a substance. For example, if water and alcohol are combined, the resulting substance will have two boiling points: the boiling point of the alcohol (~70°C) and the boiling point of the water (100°C). If the two had combined, the resulting substance would have a single boiling point.

*For purposes of this standard, it is reasonable to assume that if two substances do combine, they do so completely, resulting in a new pure substance without contaminants.*

**Learning Targets - DCIs**
*Matter and Its Interactions*

1. When two pure substances are mixed the outcome can either be a complete interaction which creates a new pure substance with new physical and chemical properties (e.g. boiling point and flammability) OR the two substances do not interact, and the outcome is a mixture and the components keep their individual properties.
2. Ways to separate a mixture: filtration, evaporation, distillation, etc.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Given a list of pure substances and mixtures obtain information to distinguish between pure substances and mixtures and provide the characteristics used to distinguish (structure and function/patterns).
2. Conduct an investigation to separate the components of an unknown substance to show the patterns used to distinguish between mixtures and pure substances.
3. Engage in argument using evidence classifying matter as a pure substance or a mixture highlighting the identifiable patterns that are found in both types of matter.

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

| Anchoring: | Investigative: |
|---|---|
| • When solid bath bombs are added to water, they start breaking apart, and gas bubbles appear on and around them for a few minutes, until no solid is left. | • Some metals can be found on the periodic table while others cannot.<br>• When pure cane sugar is added to sulfuric acid, a black substance appears. |

**Lesson Resources**

- ***UPDATED!*** Bath Bombs Teacher Guide (storyline unit goes with bath bombs anchoring phenomenon and standards 7.PS1.1-1.5)
  - Bath Bomb folder
- Lesson from TDOE: Asking questions and defining problems (lesson goes with anchoring phenomenon)
  - The Proposal Problem (interactive/digital version of card sort from the TDOE lesson)
- Pure Substances vs. Mixtures (video)
- Evaluate: Pure Substances and Mixtures(video)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 6-9; 14-19; 19A-G; 36-39<br>SE: 6-9; 14-19; 36-39 | 5.PS1.3 Design a process to measure how different variables (temperature, particle size, stirring) affect the rate of dissolving solids into liquids. |

| Content to Explore | | |
|---|---|---|
| matter | pure substance | 5.PS1.4 Evaluate the results of an experiment to determine whether the mixing of two or more substances result in a change of properties. |
| mixture | chemical properties | |
| physical properties | boiling point | |

| 7.PS1.4 | Analyze and interpret chemical reactions to determine if the total number of atoms in the reactants and products support the Law of Conservation of Mass. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

Analysis could include either analysis of models of a reaction, or analysis of data collected during a reaction. The purpose of the analysis is to gather evidence that the mass of the reacting substances does not change, although their form may. **Balancing a chemical reaction is beyond the scope of this standard.**

Models might include written chemical reactions but should also be supplemented with physical models such as molecular sets that can be assembled, disassembled, and reassembled to demonstrate that rearrangement of atoms which occurs in a chemical reaction.

Analysis should include conceptually recognizing that the conservation of mass only occurs because the mass (total number of protons and neutrons per atom (7.PS1.1)) of each atom in the reactants does not change. **Discussions of moles and molar masses are beyond the scope of the grade band.**

**Learning Targets - DCIs**
*Matter and Its Interactions*

1. Polyatomic ions are a set of atoms that function as a single atom. Coefficients proceed a substance and represent the number of atoms/molecules/formula units in a balanced reaction.
2. Counting atoms in a chemical equation (total # of reactants should = total # of products).
3. Chemical reactions do not create new atoms but rearrange the same atoms to make new molecules/substances conserving the mass of the reactant in the products.
4. Law of Conservation of Mass (total number of protons and neutrons per atom) can be proven using models/equations understanding that matter was not created or lost, only changed.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Using a model (diagram), count the number of atoms of each element before and after the chemical reaction and interpret the data to see if the law of conservation was met (energy and matter).
2. Develop a model of a chemical reaction showing how mass is conserved (energy and matter).
3. Analyze and interpret data from a chemical equation to determine if the reactants and products meet the law of conservation of mass (energy and matter).
4. Develop an argument using the data as evidence to describe a change in a molecule (energy and matter).

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

Anchoring:

- When solid bath bombs are added to water, they start breaking apart, and gas bubbles appear on and around them for a few minutes, until no solid is left.
- The mass of a car changes when it rusts.
- Indonesia's Kawah Ijen volcano emits rivers of blue light.

Investigative:

- If baking soda and vinegar are mixed in an open container the resulting mixture weighs less than the starting materials.
- When Alka-Seltzer is placed in an open container of water the mass of the system (water and Alka-Seltzer) is less after the reaction.
- When magnesium ribbon is strongly heated, it glows and gains mass.
- You can light a match with a rubber band.
- Burning steel wool leads to an increase in mass.
- Gas bubbles come from the positive and negative ends of a battery when placed in salt water.

**Lesson Resources**

- ***UPDATED!*** Bath Bombs Teacher Guide (storyline unit goes with bath bombs anchoring phenomenon and standards 7.PS1.1-1.5)
    - Bath Bomb folder

- Lesson from TDOE: Using mathematics and computational thinking
- Modeling Law of Conservation of Mass Stations
- Chemistry in a Ziplock bag
  - Instructions
  - Observation sheet
- Law of Conservation of Mass Lab
  - Video
- Iron is Conserved (from summer PD goes with rusting car anchoring phenomenon)
- Iron is Conserved (GRC lesson goes with rusting car anchoring phenomenon)
  - Supplemental video: Steel Wool in Vinegar (The Sci Guys)
- Exploding hydrogen bubbles (performance task goes with the investigative phenomenon of the same name)
- Atom Counting: Looking at How Chemical Formulas are Written

| Textbook Connections | Previous Standard(s) |
|---|---|
| **TE:** 26-33; 35A-H; 36-39; 126-161<br>**SE:** 6-9; 14-19; 36-39; 126-161 | 5.PS1.2 Analyze and interpret data to show that the amount of matter is conserved even when it changes form, including transitions where matter seems to vanish |
| **Content to Explore** | |
| polyatomic ions<br>chemical equation<br>products<br>Law of Conservation of Mass<br>coefficient<br>reactants<br>chemical reaction | |

| 7.PS1.5 | Use the periodic table as a model to analyze and interpret evidence relating to physical and chemical properties to identify a sample of matter. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

Unlike properties such as atomic radii and electronegativity, the chemical and physical properties, referenced in this standard include bulk properties of matter. Bulk properties are only observable in a sample of a substance (element or compound) comprised of multiple particles and are a result of the way that the particles interact with each other. Examples might include density, melting points, boiling point, solubility, flammability, or color, conductivity.

Whenever possible, connections in the behaviors of atoms should be connected back to the organization of the periodic table.

*It is not necessary for students to explain the mechanisms (inter-molecular attractions) that cause the patterns in physical properties.*

**Learning Targets - DCIs**
*Matter and Its Interactions*

1. Periodic table organization – arranged by protons and outermost electrons (valance electrons, rows are periods, columns are groups/families that have similar properties
2. Physical and chemical properties (density, melting point, boiling point, solubility, flammability, color, conductivity)
3. An element in a particular family or a compound will have a certain set of properties because of its location on the periodic table and its subsequent behavior and compounds have certain properties based on the elements used to create the compound.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Identify (engage in argument from evidence) an unknown element by the number of protons in the atom of that element using the organization of the periodic table as evidence (patterns).
2. Distinguish between physical and chemical properties of elements by providing evidence supported examples (patterns/structure and function).
3. Analyze and interpret data from the periodic table to identify relationships and predict the physical and chemical properties of an element based on its location on the periodic table (patterns).

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

Anchoring:

- When solid bath bombs are added to water, they start breaking apart, and gas bubbles appear on and around them for a few minutes, until no solid is left.
- Aluminum chloride ($AlCl_3$) has a low boiling point compared to aluminum oxide ($Al_2O_3$)

Investigative:

- When magnesium is burned, it creates a bright glow.
- There were large explosions at Lake Lenore, Washington after 10 tons of sodium was dumped into the lake.
- When vinegar is put on the hard water crust on sink or shower faucets, the white crust begins to bubble.

**Lesson Resources**

- ***UPDATED!*** Bath Bombs Teacher Guide (storyline unit goes with bath bombs anchoring phenomenon and standards 7.PS1.1-1.5)
  - Bath Bomb folder
- Physical and Chemical Properties Stations
  - Station signs
  - Student handout
- To Change or Not to Change—That is the Question (GRC lesson goes with the vinegar investigative phenomenon)
- Physical and Chemical Changes (performance task)

- Organizing Properties: Crash Course Kids #35.1 (video)
- What's My Property: Crash Course Kids #35.2 (video)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 4-13H; 90A-B; 90-123<br>SE: 4-13H; 90-123 | 5PS1.1 Analyze and interpret data from observations and measurements of the physical properties of matter to explain phase changes between a solid, liquid, or gas. |

**Content to Explore**

| | |
|---|---|
| periodic table | physical properties |
| chemical properties | bulk properties |
| melting point | boiling point |
| solubility | flammability |
| color | conductivity |
| density | compound |

| 7.PS1.6 | Create and interpret models of substances whose atoms represent the states of matter with respect to temperature and pressure. |
|---|---|

**TDOE Standard Explanation**

*Taken from the TN Science Standards Reference Document (updated 2019)*

The state of matter of a substance is dependent on three factors: the intermolecular attractions between the atoms/molecules of the substance, the external pressure on the substance, and the temperature of the substance.

Models should account for particles, a vessel containing the particles, the motion (average kinetic energy) of the particles, and the total thermal energy of the system and the interactions between these components. Models can be used to explain why some substances such as hydrogen and helium atoms exist primarily as gasses due to very weak intermolecular attractions. Even very small amounts of motion are capable of overcoming the attractions between molecules.

This contrasts with substances such as ionic compounds which have extremely strong intermolecular attractions keeping atoms in a very organized crystal lattice pattern even at high temperatures. Pressure can be seen as an external force from surrounding matter pushing the particles closer together. Students should attribute pressure to the vessel containing the sample. It is logical to incorporate triple point diagrams into discussions.

Students should use models to connect how changes in pressure impact the change in thermal energy that is required for phase transformations to occur.

*(Students are not expected to differentiate between the types of intermolecular attractions, merely to recognize that some force must be holding together the particles in a solid, and that overcoming this force causes a phase change.)*

**Learning Targets - DCIs**

*Matter and Its Interactions*

1. The internal bonds, pressure and temperature acting on a substance determines the state of matter or a change in state of a substance.
2. Particle appearance and movement in each state of matter (solids- close together and vibrate, liquid – space between and slide past each other, and gas – far apart and collide everywhere)

**Tasks and Assessments—SEPs & CCCs**

*Each task and assessment correspond with a learning target.*

1. Using a model of a substance at different temperatures and pressures, identify the state of matter citing identified patterns as evidence.
2. Create an atomic model of a substance in different states of matter under different temperature and pressures explaining the cause and effect relationships.

**Phenomena—Anchoring & Investigative**

*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

Anchoring:

- A frozen sample of matter can boil.
- An empty tanker car was steam-cleaned, sealed, and left overnight. At some point, the massive, sturdy tanker car imploded on itself in an instant.
- Soap bubbles can instantly freeze into ice orbs.
- Aquamate Inflatable Solar Stills utilize solar radiation to distill and collect pure drinking water from sea or impure water.

Investigative:

- Water can be “supercooled” below its freezing point.
- When you put a marshmallow in a vacuum sealed container, it expands.
- Marshmallows can expand in a syringe.
- Clouds form as air passes over mountain tops.
- Airplanes leave contrails when flying at high altitudes.

**Lesson Resources**

- Unit from TDOE: A Compound in Three States of Matter at Once (unit goes with frozen matter anchoring phenomenon and marshmallow/syringe investigative phenomenon)
- Clean Water (lesson goes with Aquamate anchoring phenomenon)
- How to Supercool Water: A SciShow Experiment (video goes with supercooled water investigative phenomenon)
- PhET: States of Matter Intro Lab (Nearpod)

<table>
<tr><th>Textbook Connections</th><th>Previous Standard(s)</th></tr>
<tr><td>TE: 20A-33; 36-39; 42-75F<br>SE: 20-33; 36-39; 42-75</td><td rowspan="3">5.PS1.1 Analyze and interpret data from observations and measurements of the physical properties of matter to explain phase changes between a solid, liquid, or gas.<br><br>5.PS1.3 Design a process to measure how different variables (temperature, particle size, stirring) affect the rate of dissolving solids into liquids.</td></tr>
<tr><th>Content to Explore</th></tr>
<tr><td>atoms<br>temperature<br>intermolecular attractions<br>thermal energy<br>triple point diagram<br>states of matter<br>pressure<br>kinetic energy<br>ionic compounds</td></tr>
</table>

| 7.LS1.1 | Develop and construct models that identify and explain the structure and function of major cell organelles as they contribute to the life activities of the cell and organism. |
|---|---|

**TDOE Standard Explanation**

*Taken from the TN Science Standards Reference Document (updated 2019)*

Cell models should be a tool that students use to make sense of phenomena, not the outcome of student learning. The focus of this standard is to understand that cell organelles work as a system. Single cells (including those within multicellular organisms) must obtain food and water, as well as remove waste— just like multicellular organisms. Organelles distribute these responsibilities, increasing efficiency.

Students should be able to identify cellular structures in models in order to account for various cellular activities or to differentiate between plant and animal cells. Students should be able to describe how the components provide the energy that sustains cellular processes, provide structure to the cell, or work together to accomplish cellular functions.

Models might be drawn or physical representations of cell parts. Students can compare the main parts of the cell to the parts of a factory or school in function. Microscopes are a great way to examine their own cheek cells.

Emphasis is on the function of organelles individually and as part of a larger system of organelles (nucleus, chloroplast, mitochondria, cell membrane, cell wall, vacuole, and cytoplasm).

**Learning Targets - DCIs**

*From Molecules to Organisms: Structure and Processes*

1. Cells are made of organelles which all have different functions based on their structure but work together to make the cell work properly.
2. Animal and plant cells have different organelles (chloroplast, larger vacuole, cell wall, etc.).
3. The components of a cell (plant or animal) work together to carry out life processes similar to the way the parts of a school work together.

**Tasks and Assessments—SEPs & CCCs**

*Each task and assessment correspond with a learning target.*

1. Develop and use a model to describe the structure and function of a cell and its parts.
2. Construct an evidence-based explanation of an analogy comparing a cell and its organelles to a school, city, building, etc. and its parts (structure and function).
3. Engage in argument from evidence comparing two cell organelles and how they work together to carry out a common function.

**Phenomena—Anchoring & Investigative**

*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

| Anchoring: | Investigative: |
|---|---|
| • When M'Kenna was 13, she started losing weight and feeling sick all of the time.<br>• Roots are not green.<br>• Leaves are darker on top as compared to the underside. | • Red blood cells do not have a nucleus. |

**Lesson Resources**

- ***UPDATED!*** A Medical Mystery Teacher Guide (storyline unit taught with M'Kenna anchoring phenomenon and standards 7.LS1.1, 1.2, 1.4, 1.5, 1.9, and 7.ETS2.1)
  - A Medical Mystery folder with student journal, handouts, and other resources
- The Root of the Matter (GRC lesson goes with roots anchoring phenomenon)
- Organelle Case Studies (students can use case studies to see what organelles are defective using evidence from the case study and their knowledge of cell organelles)
- Green Leaves (GRC lesson goes with leaves anchoring phenomenon)
- Where's My Nucleus?! (GRC lesson goes with red blood cells investigative phenomenon)
- Why Red Blood Cells Look Like Donuts (video goes with the red blood cells investigative phenomenon)
- The Pool Has Ruined the Grass (performance task/assessment)
- Introduction to Cells: The Grand Cell Tour (Amoeba Sisters)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 164-169, 169A-B, 170-177, 177A-H, 178A-B, 178-187, 187A-H<br>SE: 170-177; 178-187 | 3.LS1.1 Analyze the internal and external structures that aquatic and land animals and plants have to support survival, growth, behavior, and reproduction. |
| **Content to Explore** | |
| cell<br>single cellular<br>nucleus<br>mitochondria<br>cell wall<br>cytoplasm<br>cell organelles<br>multicellular<br>chloroplast<br>cell membrane<br>vacuole | |

| 7.LS1.2 | Conduct an investigation to demonstrate how the cell membrane maintains homeostasis through the process of passive transport. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

The most critical functions of the cell membrane are maintaining cell structure and controlling the materials entering the cell.

A typical and sufficient phenomenon for this standard includes dissolving the eggshell from an egg and exposing the egg to varying solutions. It is not necessary for students to memorize terms describing the solutions (e.g. hypertonic), however students should work with models representing the microscopic components of the solution to make sense the macroscopic changes to their eggs. It is critical that students draw their understanding of this concept beyond simply explaining this one instance of passive transport, but also other analogous instances. Examples might include explaining the function of the contractile vacuoles in plants, or the way that some plants such as *Mimosa pudica* utilize solute concentrations to "reset" after they have been touched.

**Learning Targets - DCIs**
*From Molecules to Organisms: Structures and Processes*

1. The cell membrane (semi-permeable) controls what enters and leaves a cell to maintain 'equilibrium' or homeostasis, a stable internal environment despite external environment, which allow smaller molecules like water to enter, but larger molecules cannot.
2. Passive transport like diffusion and osmosis, requires no energy on the cell's part because it is moving from high to low concentration levels but active transport requires energy because the molecules are larger and move from low to high concentrations.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Plan and carry out an investigation to show that a cell membrane maintains homeostasis highlighting that passive transport contributes to the stability of a cell.
2. Plan and carry out an investigation to demonstrate particle movement through a semipermeable membrane (system and system models).
3. Analyze and interpret the data from the investigation (measurements and observations before and after the investigation) to construct an explanation and develop a model of what occurred within the system.
4. Develop and use models to show the direction of particle movement across the membrane using an understanding of the cause and effect relationship between the concentration of materials and where those materials move in active and passive transport.

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

Anchoring:
- When M'Kenna was 13, she started losing weight and feeling sick all of the time.
- Eggs can grow and shrink without being cooked or cracked.
- If salt is placed on a slug, it will change the length and health of the slug.

Investigative:
- When a plastic bag of cornstarch is placed in iodine solution, the cornstarch changes colors.
- A carrot placed in salt water becomes limp; a carrot placed in fresh water becomes crisp.

**Lesson Resources**

- ***UPDATED!*** A Medical Mystery Teacher Guide (storyline unit taught with M'Kenna anchoring phenomenon and standards 7.LS1.1, 1.2, 1.4, 1.5, 1.9, and 7.ETS2.1)
  - A Medical Mystery folder with student journal, handouts, and other resources
- Lesson from TDOE: Planning and carrying out investigations
- Salted Slug (performance task/assessment goes with slug anchoring phenomenon)
- Importance of Diffusion in Organisms (article)
- Osmosis—Real-life applications (article)
- Amoeba Sisters: Inside the Cell Membrane (video)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 194A-B; 194-199; 199A-G<br>SE: 194-199 | 3.LS1.1 Analyze the internal and external structures that aquatic and land animals and plants have to support survival, growth, behavior, and reproduction. |
| **Content to Explore** | |
| semi-permeable<br>active transport<br>osmosis<br>homeostasis<br>passive transport<br>diffusion | |

| 7.LS1.3 | Evaluate evidence that cells have structural similarities and differences across kingdoms. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

Taxonomic classification has developed as human capacity to organize and observe patterns within life has increased. Carl Linnaeus developed his original classification system consisting of two biologically significant families: plants and animals. (Linnaeus also included a now defunct system for classification of minerals.)

Understanding of life cycles and the fields of microscopy have led to further expansion of these kingdoms to the six current, widely accepted, kingdoms: Archaea, Bacteria, Protista, Fungi, Plantae, and Animalia. Current revisions to these kingdoms brought on by advances in gene sequencing have raised questions as to the validity of Kingdom Protista due to the lack of similarity between organisms within this kingdom.

Activities may include comparing real plant and animal cells for presence of a nucleus, cell wall, structural orientation of cells, and presence of chloroplasts using a compound light microscope. Students can use examples of prokaryotic and eukaryotic organisms and point out the presence of the nucleus distinguishes the eukaryotes from the prokaryotes. Students should be able to differentiate and classify organisms into the six current kingdoms. Students should understand basic physical characteristics of each kingdom, i.e. being unicellular or multicellular, how food is obtained.

*(Focus is on structural and functional differences at a cellular level between domains and kingdoms as well as the introduction of increasingly more complex cell structure from prokaryotic to eukaryotic organisms.)*

**Learning Targets - DCIs**
*From Molecules to Organisms: Structures and Processes*

1. The six kingdoms—Archaea, Bacteria, Protista, Fungi, Plantae, and Animalia—have specific physical characteristics such as unicellular, multicellular, organelles present, shape, and how food is obtained, that allow for differentiation.
2. Cells in a certain kingdom share characteristics.
3. The presence of a nucleus distinguishes the eukaryotes from the prokaryotes.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Obtain, evaluate and communicate information in order to identify physical characteristics of each kingdom highlighting that patterns can be found among organisms within a kingdom.
2. Cite evidence in an argument in order to distinguish between the kingdoms highlighting that patterns can be found among organisms within a kingdom.
3. Construct an explanation in order to compare cells/organelles within each kingdom highlighting that the structure of a cell/organelle supports the functions.

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

Anchoring:
- Evidence of organic components that would indicate products or precursors of cells have been found on Mars.

Investigative:
- Certain bacteria divide only once every 100 years. (TE 232)
- Viruses do not fit into any of the kingdoms.
- The Kingdom Plantae dominates our world.

**Lesson Resources**

- Lesson from TDOE: Engaging in Argument from Evidence (lesson goes with Mars anchoring phenomenon)
- Prokaryotic and Eukaryotic Cells Lesson Plan (5E lesson)
- Amoeba Sisters: Prokaryotic vs. Eukaryotic Cells (video)
- Eukaryotes and Prokaryotes—Similarities and Differences (5E lesson)
- Kingdom Who Am I?

| Textbook Connections | | Previous Standard(s) |
|---|---|---|
| TE: 164-193H; 200-203<br>SE: 164-193; 200-203 | | 3.LS1.1 Analyze the internal and external structures that aquatic and land animals and plants have to support survival, growth, behavior, and reproduction. |
| **Content to Explore** | | |
| taxonomic classification | kingdoms | |
| Archaea | Bacteria | |
| Protista | Fungi | |
| Plantae | Animalia | |
| eukaryotes | prokaryotes | |

| 7.LS1.4 | Diagram the hierarchical organization of multicellular organisms from cells to organism. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

Students should recognize that the specialization of larger organs scales down all the way to specialization individual cells. At the smallest level, groups of specialized cells work together to form tissues. Organs themselves are then composed of some of these different tissue types.

While students are not expected to know all tissue types, it is reasonable to examine several organs to observe that within a single organ there are a variety of tissue types. For example, the lungs contain connective tissues, the specialized cells of the epithelium, etc.

Groups of organs can also work together to form organ systems and these systems interact with one another to support multicellular organisms. For example, the respiratory and circulatory systems work together to supply oxygen to cells.

**Learning Targets - DCIs**
*From Molecules to Organisms: Structures and Processes*

1. Cells can be specialized to do different tasks or complete different functions.
2. When multiple of the same type of specialized cell works together a tissue is formed. Types of tissues that work together create larger organs. Organs that work together to complete a function create organ systems which help the organism survive.
3. Specialized organs are 'specialized' all the way down to their individual cells that work together towards one common goal.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Construct an explanation in order to show that cells are specialized according to specific tasks highlighting how the structure of a cell determines the function.
2. Develop a model in order to diagram the hierarchical organization of multicellular organisms highlighting how the components of an organism work as a system.
3. Engage in argument from evidence in order to explain the hierarchical organization of a given multicellular organism highlighting how the components of an organism work as a system.

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

Anchoring:
- When M'Kenna was 13, she started losing weight and feeling sick all of the time.
- The result of beta cells in the pancreas being damaged is a disease known as diabetes.
- A tomato and a tooth are both made of cells, but they look different.

Investigative:
- A group of cells can be called a colony or a tissue.
- In the United States alone, roughly 22 million people have been diagnosed with asthma, and approximately 6 million of them are children.
- I can feel my pulse in my neck after I exercise.
- Synesthesia is a condition where a person experiences a blending of the senses—hear colors, feel sounds, and taste shapes.

**Lesson Resources**

- ***UPDATED!*** A Medical Mystery Teacher Guide (storyline unit taught with M'Kenna anchoring phenomenon and standards 7.LS1.1, 1.2, 1.4, 1.5, 1.9, and 7.ETS2.1)
  - A Medical Mystery folder with student journal, handouts, and other resources
- Lesson from TDOE: Obtaining, evaluating, and communicating information (lesson goes with the tomato and tooth anchoring phenomenon)
- Pancreatic Cells (performance task/assessment goes with beta cells anchoring phenomenon)
- Health Report (GRC lesson goes with asthma investigative phenomenon)
- My Pulse (GRC lesson goes with pulse investigative phenomenon)

- cK-12: Organization of Living Things
- Levels of Organization (video)
- Levels of Biological Organization

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 178A-B; 186-187; 187-A-H; 200-203; 448A-453H; 488-491<br>SE: 186-187; 200-203; 448-453; 488-491 | 3.LS1.1 Analyze the internal and external structures that aquatic and land animals and plants have to support survival, growth, behavior, and reproduction. |

| Content to Explore | |
|---|---|
| hierarchical organization | cell |
| tissue | organ |
| organ system | organism |

| | |
|---|---|
| 7.LS1.5 | Explain that the body is a system comprised or subsystems that maintain equilibrium and support life through digestion, respiration, excretion, circulation, sensation (nervous and integumentary) and locomotion (musculoskeletal). |

**TDOE Standard Explanation**

*Taken from the TN Science Standards Reference Document (updated 2019)*

The model developed for 7.LS1.4, is a tool for making sense of events in the natural world. If such a diagram is not as a tool for understanding, it is merely a picture and not a model. This standard is an opportunity to use the models developed in 7.LS1.4 to understand how organ systems interact within organisms.

In the context of this standard, the word equilibrium is used synonymous to homeostasis, as opposed to a chemical equilibrium. For example, students might develop explanations for how it is possible that everyone's body is nearly the same temperature despite engaging in different activities, under different environmental conditions. In their explanations, students the distinct roles of individual systems can be used as evidence that there must be coordination between systems in order for the organism to maintain equilibrium.

*The focus of this standard is on recognizing that systems do interact with each other, not on memorizing all possible types of interactions, nor specific chemicals involved in the pathways. The more technical elements of homeostasis, such as feedback loops, are beyond the scope of the grade band.*

**Learning Targets - DCIs**

*From Molecules to Organisms: Structures and Processes*

1. Organisms must remain stable (balanced) in varying environmental conditions/activities to ensure survival. (Equilibrium/Homeostasis)
2. Each body system/major organs have a subsystem of life processes—digestion, respiration, excretion, circulation, sensation (nervous and integumentary) and locomotion (musculoskeletal).
3. Body systems and their subsystems of life processes can interact together to maintain equilibrium.

**Tasks and Assessments—SEPs & CCCs**

*Each task and assessment correspond with a learning target.*

1. Plan and carry out an investigation in order to show that organisms work to maintain equilibrium within a changing environment highlighting that there is a cause an effect relationship at work.
2. Construct explanations in order to show the body processes that support life highlighting that the human body is a system composed of subsystems (Digestion, Respiration, Excretion, Circulation, Sensation (nervous and integumentary), and Locomotion (musculoskeletal).
3. Engage in an argument from evidence in order to show that the body's subsystems interact together highlighting that the human body maintains stability in varying environmental conditions and activities.

**Phenomena—Anchoring & Investigative**

*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

Anchoring:

- When M'Kenna was 13, she started losing weight and feeling sick all of the time.
- A Georgia high school football player collapsed after drinking 4 gallons of water and Gatorade during and after practice.
- A baby's life was saved with a 3D printed device that restored his breathing.

Investigative:

- "Runner's high" is a feeling of euphoria that occurs during and after strenuous exercise.
- When I wake up from sleeping, I know it is time to eat; after I eat, I eventually feel full and know when to stop eating.

**Lesson Resources**

- ***UPDATED!*** A Medical Mystery Teacher Guide (storyline unit taught with M'Kenna anchoring phenomenon and standards 7.LS1.1, 1.2, 1.4, 1.5, 1.9, and 7.ETS2.1)
  - A Medical Mystery folder with student journal, handouts, and other resources
- Biomedical Engineering Design Solution (investigation goes with 3D printed device anchoring phenomenon and standards 7.LS3.1 and 7.ETS2.1)
- Amoeba Sisters: Human Body Systems Functions Overview (video)

- Explore the Human Body
- BBC Bitesize: Homeostasis (video)
- How your digestive system works (video)

| Textbook Connections | Previous Standard(s) |
|---|---|
| **Animal Systems**<br>**TE:** 382A-B; 387A-G; 388A-B; 393A-G; 418A-B; 425A-G<br>**SE:** 382-387; 388-393; 408-411; 415-417, 418-425<br>**Human Systems**<br>**TE:** 448A-B; 453A-G, 454A-B; 461A-H; 462A-B, 469A-G, 470A-B, 477A-H; 478A-B; 483A-G; 484A-B, 487A-G<br>**SE:** 448-453; 454-461, 462-469, 470-477, 478-483, 484-487 | 3.LS1.1 Analyze the internal and external structures that aquatic and land animals and plants have to support survival, growth, behavior, and reproduction. |

| Content to Explore | |
|---|---|
| body system | homeostasis/equilibrium |
| digestion | respiration |
| excretion | circulation |
| sensation (nervous and integumentary) | locomotion (musculoskeletal) |

| 7.LS1.6 | Develop an argument based on empirical evidence and scientific reasoning to explain how behavioral and structural adaptations in animals and plants affect the probability of survival and reproductive success. |
|---|---|

**TDOE Standard Explanation**

*Taken from the TN Science Standards Reference Document (updated 2019)*

The focus of this standard is reproductive strategies in plants and animals, with a secondary connection to the way that these strategies have been cemented over time. Discussions of the adaptations support the main focus on reproductive success. Structural adaptations in animals could be things such as coloration, or patterns, along with behaviors that increase success in attracting a mate such as vocalization. Plants have structures that attract pollinators or foster interactions with specific pollinators, or seeds with features that aid in dispersion by wind or interactions with animals.

Instructionally, it is not necessary to focus on presenting students with as many interactions/structures as possible. Instead, time should be taken to allow students to observe patterns in interactions (between same species, or different species) and allow students to present arguments with how these interactions increase reproductive success. Students should closely examine the interactions searching for a cause-effect relationship between the behavior and reproductive success.

*Internal and external structures that help an organism survive in their environments (e.g. swim bladder in fish), but not associated with reproduction, but have been covered in third grade.*

**Learning Targets - DCIs**

*From Molecules to Organisms: Structures and Processes*

1. Adaptations help plants and animals survive in their environment and attract a mate.
2. Structural adaptations are the way a plant or animal looks or is made (coloration, patterns, pollination features) which helps it survive and attract a mate, and behavioral adaptations are the way an animal behaves (vocalization, hunting in groups, weaving/pebbles for mating) which helps it survive and attract a mate.
3. There is a cause and effect relationship between adaptations and reproductive success.

**Tasks and Assessments—SEPs & CCCs**

*Each task and assessment correspond with a learning target.*

1. Obtain, evaluate, and communicate information of various adaptations in plants and animals in order to show how these adaptations help with survival highlighting that the structure/function of certain adaptations contribute to survival and reproductive success.
2. Develop and use a model in order to distinguish between structural/behavioral adaptations highlighting that the structure/function of adaptations contribute to survival/reproductive success.
3. Engage in argument from evidence in order to show the correlation between adaptations and reproductive success highlighting that there is a cause/effect relationship between certain adaptations and reproductive success.

**Phenomena—Anchoring & Investigative**

*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

Anchoring:

- Superheroes and real-life superbeings have special abilities.
- Mangrove trees have become specialized to survive in the extreme conditions of estuaries.
- Blue crabs and oysters live in estuaries and must change their behavior according to the surrounding waters' salinity in order to survive.
  **Scroll down and find the Blue Crabs section.*
- Global climate change continues to put pressure on the health and survival of these Arctic organisms, making some adaptations detrimental to their survival.

Investigative:

- Weaverbirds build elaborate nests to woo females.
- Mouthbrooding Cichlid starve to protect their young.
- Shrews form a long caravan to move offspring from one location to another.
- The Himalayan Balsam seed pods explode to survive.
- The Kamehameha Butterfly spends its life on mamaki plants.
- Blood-filled sinuses with the eye sockets of horned lizards squirt blood.

**Lesson Resources**

- ***NEW!*** Superhero Origin Stories Teacher Guide (storyline unit taught with superhero anchoring phenomenon and standards 7.LS1.6-1.8 and 7.LS3.1-3.3)
    - Superhero Origin Stories folder with student journal, handouts, and other resources
- Well Adapted in the Arctic (lesson/unit goes with global climate change/Arctic anchoring phenomenon and standard 7.LS3.1)
- What Is My Adaptation?
- Natural Selection: Bird Beaks
- Pulelehua Pollinators (GRC lesson goes with the Kamehameha Butterfly investigative phenomenon)
- More information on horned lizard:
    - The Lizard Shoots Blood from Its Eyes (video)
    - Short-Horned Lizard (article)
- Bloody Lizard, Chinese Water Deer, and the Shrew-Poo Pitcher Plant (performance task/assessment)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 351 A-G; 425 A-G<br>SE: 344-351; 418-425 | 5.LS1.1 Compare and contrast animal responses that are instinctual versus those that are gathered through the senses, processed, and stored as memories to guide their actions. |
| **Content to Explore** | |
| behavioral adaptations<br>survival<br>structural adaptations<br>reproductive success | |

| 7.LS1.7 | Evaluate and communicate evidence that compares and contrasts the advantages and disadvantages of sexual and asexual reproduction. |
|---|---|

**TDOE Standard Explanation**

*Taken from the TN Science Standards Reference Document (updated 2019)*

In the context of *Growth and Development of Organisms* students should become aware that there are different strategies that organisms use for reproduction. The 7.LS3 standards address cellular processes of associated with reproduction.

In sexual reproduction include genetic variation, while asexual reproduction results in far less genetic variation. By bundling this standard with discussions of cellular processes, students can compile evidence to explain why genetic variation occurs in sexual reproduction. Students should consider the origin of the genetic information in the offspring.

**Learning Targets - DCIs**

*From Molecules to Organisms: Structures and Processes*

1. Advantages of sexual reproduction: produces genetic variation in the offspring, the species can adapt to new environments due to variation, which gives them a survival advantage, a disease is less likely to affect all the individuals in a population.
2. Disadvantages of sexual reproduction: requires two organisms and more time and energy are needed to find a mate.
3. Advantages of asexual reproduction include: the population can increase rapidly when the conditions are favorable, only one parent is needed, it is more time and energy efficient as you don't need a mate.
4. Disadvantages of asexual reproduction: does not lead to genetic variation in a population, species may only be suited to one habitat, and disease may affect all the individuals in a population.

**Tasks and Assessments—SEPs & CCCs**

*Each task and assessment correspond with a learning target.*

1. Obtain, evaluate, and communicate information in order to show similarities and differences between sexual and asexual reproduction highlighting the advantages and disadvantages of the two types of reproduction (patterns).
2. Develop and use a model comparing how asexual and sexual reproduction affect genetic variation in offspring.
3. Construct an explanation predicting how biodiversity in an environment would be affected by sexual reproduction compared to asexual reproduction in an organism.

**Phenomena—Anchoring & Investigative**

*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

Anchoring:

- Superheroes and real-life superbeings have special abilities.
- Many species of whiptail lizards are all female that reproduce without males.
- Some organisms, like the starfish, can reproduce both sexually and asexually.

Investigative:

- A log from a Russian olive tree left on wet soil grows roots and eventually grows into a tree.
- Raspberry plants, like the ones in my neighbor's yard, have started growing in my yard.
- Earth's largest known living organism is a Quaking Aspen grove in Utah known as "Pando".

**Lesson Resources**

- ***NEW!*** Superhero Origin Stories Teacher Guide (storyline unit taught with superhero anchoring phenomenon and standards 7.LS1.6-1.8 and 7.LS3.1-3.3)
    - Superhero Origin Stories folder with student journal, handouts, and other resources
- Lizard Reproduction (lesson that goes with lizard anchoring phenomenon)
- Telomeres and Starfish (lesson goes with starfish anchoring phenomenon and standard 7.LS3.3)
- Sexual vs. Asexual Reproduction (interactive)
- Reproduction: One Goal, Two Methods (lesson)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 425 A-G<br>SE: 418-425 | 3.LS1.1 Analyze the internal and external structures that aquatic and land animals and plants have to support survival, growth, behavior, and reproduction. |
| **Content to Explore** | |
| sexual reproduction asexual reproduction<br>genetic variation | |

| 7.LS1.8 | Construct an explanation demonstrating that the function of mitosis for multicellular organisms is for growth and repair through the production of genetically identical daughter cells. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

Understanding the significance of mitosis requires that students incorporate conservation of mass into their discussions (7.PS1.4). In order for organisms to grow, they must consume matter, and this matter must be broken down, and reassembled into the molecules that make up cellular components. Simple questions such as, "How do animals grow larger?" allow students to connect their knowledge about the hierarchy of structures in living organisms to their models for mitosis, rather than simply learning the phases of mitosis, devoid of any conceptual significance.

*The mechanisms by which DNA moves from parent cell to daughter cell is addressed in 7.LS3.2. Recognizing that growth requires mitosis and inputs of matter is central to 7.LS1.8.*

**Learning Targets - DCIs**
*From Molecules to Organisms: Structures and Processes*

1. In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing organisms to grow , heal, and replace cells.
2. The organism begins as a single cell that divides successfully to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both identical daughter cells.
3. Cellular division and differentiation produce and maintain a complex organism—cuts heal with the correct cells (e.g. skin grows back as skin and not hair) and tissues and organs have specialized cells.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Obtain, evaluate, and communicate information about the purpose of mitosis in multicellular organisms (processes of cell/organism growth, damaged cell repair, and cell replacement) highlighting that matter flows into, out of, and within the cell (system) creating identical daughter cells.
2. Develop a model to show the process/phases of mitosis highlighting the passing of identical genetic material (matter) between parent cells and identical daughter cells.
3. Construct an explanation to demonstrate that function of mitosis highlighting that cells create identical copies of themselves in the transformation of matter.

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

| Anchoring: | Investigative: |
|---|---|
| • Superheroes and real-life superbeings have special abilities.<br>• After a couple of days, the cut on your finger is almost gone.<br>• My fingernail can heal itself over time. | • Baby elephants grow up to be large elephants.<br>• Reptiles shed their skin.<br>• Planarians can be cut into pieces and regrow their entire bodies, even a new head. |

**Lesson Resources**

- ***NEW!*** Superhero Origin Stories Teacher Guide (storyline unit taught with superhero anchoring phenomenon and standards 7.LS1.6-1.8 and 7.LS3.1-3.3)
  - Superhero Origin Stories folder with student journal, handouts, and other resources
- Lesson from TDOE: Constructing explanations and designing solutions (lesson goes with cut on finger anchoring phenomenon)
- Phases of Mitosis (article and diagrams)
- Amoeba Sisters: Mitosis (video)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 233A-G; pgs. 226-233<br>SE: 226-233 | 5.LS1.1 Compare and contrast animal responses that are instinctual versus those that are gathered through the senses, processed, and stored as memories to guide their actions. |
| **Content to Explore** | |
| mitosis daughter cells | |

| | |
|---|---|
| 7.LS1.9 | Construct a scientific explanation based on compiled evidence for the processes of photosynthesis of cellular respiration, and anaerobic respiration in the cycling of matter and flow of energy into and out of organisms. |

**TDOE Standard Explanation**

*Taken from the TN Science Standards Reference Document (updated 2019)*

Photosynthesis and respiration provide plants and animals with the matter needed for growth and the energy needed to perform necessary functions.

Plants get energy directly from the sun and store this energy in chemicals made using carbon dioxide they take in through their leaves and water absorbed through their roots. Plants get heavier (grow) using air and water alone.

Animals are dependent on plants or other animals for food. They take in food and oxygen which allows gives them energy they need, as well as the matter required to grow.

Some organisms are able to release the energy stored in food without sources of oxygen.

Evidence can be obtained by observing stomata on the underside of plant leaves, observing changes to water pH (due to dissolved gases) as a result of photosynthesis in plants such as Elodea. For an additional demonstration, use two bowls of sugar water, maintaining one as a control, while adding yeast to the other. From their 7.PS standards, students should recognize that the presence of bubbles is evidence that a substance with a boiling point lower than the water temperature has been created. This can lead into questioning of the changes and upon recognizing that the yeast might be converting sugar into a gas, whether or not significant oxygen was available to the yeast to accomplish this aerobically.

**Learning Targets - DCIs**

*From Molecules to Organisms: Structures and Processes*

1. Photosynthesis and respiration provide plants and animals with the matter needed for growth and the energy needed to perform necessary functions.
2. Plants get energy directly from the sun and store this energy in chemicals made using carbon dioxide they take in through their leaves and water absorbed through their roots.
3. Plants grow (get heavier) using air and water alone.
4. Cellular respiration takes place in the cells of plants and animals to convert chemical energy (food) from oxygen into ATP.
5. Anaerobic respiration occurs in some organisms enabling them to release energy stored in food without sources of oxygen.
6. Photosynthesis, cellular respiration and anaerobic respiration work together simultaneously to cycle matter including gases and energy in ecosystems.

**Tasks and Assessments—SEPs & CCCs**

*Each task and assessment correspond with a learning target.*

1. Plan and carry out an investigation to show photosynthesis is occurring highlighting the invisible inputs and outputs of the system.
2. Develop a model of cellular respiration that explains the inputs and outputs (systems) of the process in organisms.
3. Develop questions to determine if anaerobic respiration is taking place to maintain stability within an organism.
4. Use evidence to construct an explanation describing the processes of photosynthesis, cellular respiration, and anaerobic respiration highlighting that energy and matter cycle in and out of organisms.

**Phenomena—Anchoring & Investigative**

*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

| Anchoring: | Investigative: |
|---|---|
| • When M'Kenna was 13, she started losing weight and feeling sick all of the time.<br>• In 1960, David Latimer planted four seedlings in a jug, and he hasn't watered it since 1972. | • A candle under a jar will stay lit longer when there is a plant in the jar as well.<br>• During the Great Oxygenation Event, oxygen almost killed everything.<br>• Sunflowers follow the sun. |

| | |
|---|---|
| • Algae can be used as animal feed and fuel to reduce human dependence on fossil fuels.<br>• Caterpillars eat leaves but the leaves grow back.<br>• A kukui tree can grow out of a small seed. | • Soil is not needed to grow plants. |

**Lesson Resources**

- ***UPDATED!*** A Medical Mystery Teacher Guide (storyline unit taught with M'Kenna anchoring phenomenon and standards 7.LS1.1, 1.2, 1.4, 1.5, 1.9, and 7.ETS2.1)
  - A Medical Mystery folder with student journal, handouts, and other resources
- Submarine Dilemma (lesson goes with plants in a jug anchoring phenomenon)
- Carbon Cycle Caterpillar (GRC lesson goes with the caterpillar anchoring phenomenon)
- Miracle Growth (GRC lesson goes with the kukui tree anchoring phenomenon)
- Photosynthesis in a Jar (5E lesson)
- cK-12: Cellular Respiration and Photosynthesis

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 219A-G; 225A-G<br>SE: 214-219; 220-225 | 5.LS1.1: Compare and contrast animal responses that are instinctual versus those that are gathered through the senses, processed, and stored as memories to guide their actions. |

**Content to Explore**

| | |
|---|---|
| photosynthesis | cellular respiration |
| anaerobic respiration | glucose |
| ATP | |

| 7.LS2.1 | Develop a model to depict the cycling of matter, including carbon and oxygen, including the flow of energy among biotic and abiotic parts of an ecosystem. |
|---|---|

**TDOE Standard Explanation**

*Taken from the TN Science Standards Reference Document (updated 2019)*

7.LS1.9 and 7.LS2.1 present two different lenses for an organism's relationship with matter and energy. Standard 7.LS1.9 belongs to disciplinary core idea LS1 which explores structures and processes at a scale up to a single organism. 7.LS2.1 extends that scale to address how multiple organisms are interconnected by exchanges of matter and energy within an ecosystem.

In Discussions must include the significance of plants which are able to convert non-food materials into food materials. Carbon accounts for a major percentage of a human's weight. And while carbon dioxide surrounds us, we lose it constantly as a result of cellular respiration, and yet we are wholly dependent upon plants to make this source or carbon reusable to us.

Inversely, plants cannot be dependent on a separate set of molecules (abiotic) in order to be able to capture the sun's energy. Plants need the oxygen released by plants to store the sun's energy or use it immediately.

**Learning Targets - DCIs**

*Ecosystems: Interactions, Energy, and Dynamics*

1. Cycling of matter constantly occurs between biotic (living) and abiotic (nonliving) parts of an ecosystem.
2. Photosynthesis and cellular respiration roles in the exchange of oxygen and carbon.
3. The carbon and oxygen cycle extend beyond gas exchange, including but not limited to decomposition, use of fossil fuels, and geologic processes (i.e. volcanoes, geysers, etc.).

**Tasks and Assessments—SEPs & CCCs**

*Each task and assessment correspond with a learning target.*

1. Develop and use a model to show the cycling of matter in an ecosystem highlighting the flow of energy and matter among the components of an ecosystem.
2. Construct an explanation of the role of photosynthesis and cellular respiration in terms of the cycling of energy and matter including gases within an ecosystem.
3. Develop and use a model to illustrate the movement of carbon and/or oxygen highlighting the flow of energy and matter within an ecosystem.

**Phenomena—Anchoring & Investigative**

*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

| Anchoring: | Investigative: |
|---|---|
| • Algae can be used as animal feed and fuel to reduce human dependence on fossil fuels. | • If we are what we eat, Americans are corn and soy. |

**Lesson Resources**

- TED-Ed: The simple story of photosynthesis and food (video)
- Carbon Cycle Role-Play
- Better Lesson – Carbon and Nitrogen Cycle Part 1 (Focus on Carbon Cycle)
- Better Lesson – Carbon and Nitrogen Cycle Part 2 (Focus on Carbo Cycle)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 362-369 A-G<br>SE: 362-369 | 6.LS2.3 Draw conclusions about the transfer of energy through a food web and energy pyramid in an ecosystem.<br>6.LS2.4 Using evidence from climate data, draw conclusions about the patterns of abiotic and biotic factors in different biomes, specifically the tundra, taiga, deciduous forest, desert, grasslands, rainforest, marine, and freshwater. |
| **Content to Explore** | |
| biotic<br>carbon cycle<br>abiotic<br>oxygen cycle | |

| 7.LS3.1 | Hypothesize that the impact of structural changes to genes (i.e., mutations) located on chromosomes may result in harmful, beneficial, or neutral effects to the structure and function of the organism. |
|---|---|

**TDOE Standard Explanation**

*Taken from the TN Science Standards Reference Document (updated 2019)*

Proteins control the characteristics of an organism, both structurally and physiologically. A single chromosome will hold the information needed to produce many numbers of proteins. Each protein is produced by a gene "on" the chromosome. Metaphorically, the chromosome is a cookbook filled with recipes (genes) for many different types of meals (proteins).

A change to a gene that is found on a chromosome will influence the protein formed from that gene. This change may influence the ability of the protein produced by the gene to perform its' typical role within an organism. The observable characteristics of an organism are an outcome of protein activities. Changes to the observable characteristics of an organism may be harmful, beneficial, or have no impact on an organism.

Students should see that a protein's shape (e.g. hemoglobin) is essential to its ability to function properly and that the shape of the protein is derived from the structure of the gene. Student models should account for the sequence of general processes (not specific, technical mechanisms) that connect gene content to observable effects on the organism. The models can then be used to explain phenomena related to mutations to genes.

**Learning Targets - DCIs**

*Heredity*

1. Chromosomes are in the nucleus, genes are on chromosomes, and each gene codes for a specific protein which controls the characteristics of an organism.
2. A change to a gene, or mutation, will influence the protein formed from that gene, including the protein's ability to perform its typical job in the organism.
3. Observable characteristics of an organism are an outcome of protein activities; changes to these characteristics, or mutations, may be harmful, beneficial, or neutral.

**Tasks and Assessments—SEPs & CCCs**

*Each task and assessment correspond with a learning target.*

1. Obtain, evaluate, and communicate information for how the function of DNA and proteins are involved in the way organisms look, citing evidence to support the explanation.
2. Develop a model to describe the relationships between the components in the model-DNA, genes, proteins, and organisms (structural and physical outcomes).
3. Refine the model to describe the potential impact of structural changes to genes (mutations) may affect protein structure and function and result in observable effects of the organism.
4. Synthesize evidence and make connections to a phenomenon to make a claim that explicitly supports whether the mutation has harmful, beneficial, or neutral effects using the evidence and known scientific information.

**Phenomena—Anchoring & Investigative**

*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

Anchoring:

- Superheroes and real-life superbeings have special abilities.
- 1 in 2 million lobsters are blue.
- Some American alligators are found to be white.
- Global climate change continues to put pressure on the health and survival of these Arctic organisms, making some adaptations detrimental to their survival.
- Blind Cave Fish are missing their eyes.

Investigative:

- Insects and arachnids mimic other creatures to look threatening or unappetizing, to blend in, or to completely camouflage, but they do not choose to mimic other creatures.
- Sickle cell anemia is a rare blood disorder that could be beneficial.
- Some people get sick when they drink milk.

**Lesson Resources**

- ***NEW!*** Superhero Origin Stories Teacher Guide (storyline unit taught with superhero anchoring phenomenon and standards 7.LS1.6-1.8 and 7.LS3.1-3.3)
    - Superhero Origin Stories folder with student journal, handouts, and other resources
- Well Adapted in the Arctic (lesson/unit goes with global climate change/Arctic anchoring phenomenon and standard 7.LS1.6)
- Mystery Disease (activity goes with the blue lobster anchoring phenomenon)
    - DNA, Proteins, and Mutations (Smore goes with Mystery Disease activity—open this first!)
- Mutations Performance Assessment (goes with the white alligators anchoring phenomenon)
- Why Has Sickle Cell Disease Been Passed Down Even Though It Can Have Such Deleterious Effects?
- Blind Cave Fish (performance task/assessment)
- The Twins with Different Skin Color (performance task/assessment used with 7.LS3.2 and 7.LS3.3)
- All Sorts of Mutations: Changes in the Genetic Code (lesson)
- What is DNA and How Does it Work? (video)
- Meeting the Mutants (informational)
- Basic Genetics
- Lactose Intolerance Map: Population Percentage & Rates (TE page 294 see Engage: My Planet Diary)

**Textbook Connections**

TE: 284A-B; 289A-G; 290A-B; 293A-G; 294A-B; 299A-G
SE:284-289, 290-293; 294-299

**Content to Explore**

| | |
|---|---|
| genes | mutations |
| chromosomes | proteins |

**Previous Standard(s)**

5.LS3.1 Distinguish between inherited characteristics that results from a direct interaction with the environment. Apply this concept by giving examples of characteristics of living organisms that are influenced by both inheritance and the environment

5.LS3.2 Provide evidence and analyze data that plants and animals have traits inherited from parents and that variations of these traits exist in a group of similar organisms.

| 7.LS3.2 | Distinguish between mitosis and mitosis and meiosis and compare the resulting daughter cells. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

Daughter cells produced through mitosis are identical to the parent cells. With the exception of mutations that will occur at random, the chromosomes in the daughter cells will be identical to the chromosomes in the parent cell. This process is vital to processes such as the growth of organisms or repair to tissues (7.LS1.8).

Meiosis occurs in organisms that undergo sexual reproduction and the daughter cells are gametes (eggs or sperm). The sex cells created in meiosis are not complete. Most cells contain two copies of each chromosome, and therefore two copies of each gene to make a protein. Meiosis creates daughter cells that have only one copy of the gene to make a particular protein. It is not until a pair of sex cells combine during fertilization that a complete set of DNA is accumulated.

This halving of genetic information means that the organisms that are conceived through sexual reproduction will contain a combination of traits, half of which originates from each parent.

**Learning Targets - DCIs**
*Heredity*

1. Daughter cells produced through mitosis, a process vital for growth and repair, are identical to the parent cells.
2. Meiosis occurs in organisms that undergo sexual reproduction and the daughter cells are gametes—eggs or sperm.
3. The process of meiosis makes incomplete daughter cells with half the number of chromosomes so when they (sperm and egg) combine (fertilize) they will create a full DNA set (46 chromosomes) that allows for genetic variation in a population due to cross over of genes during the phases of meiosis.
4. Halving the genetic information means that the organisms that are conceived through sexual reproduction will contain a combination of traits, half of which originates from each parent.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Develop a model of the two types of cell division (mitosis vs. meiosis) in order to compare the different outcomes of each processes (cause and effect).
2. Construct an explanation for the process of meiosis resulting in genetic variation within a species (cause and effect).
3. Analyze and interpret data (diagrams/models) from cell cycle/division scenarios to determine whether the resulting cells were created through mitosis or meiosis (cause and effect).

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

| Anchoring: | Investigative: |
|---|---|
| • Superheroes and real-life superbeings have special abilities.<br>• The seemingly unrelated ladies in this image are not just related but are twins. | • Roses can reproduce through either pollination or cuttings.<br>• Humans are diploid but possess haploid cells. |

**Lesson Resources**

- ***NEW!*** Superhero Origin Stories Teacher Guide (storyline unit taught with superhero anchoring phenomenon and standards 7.LS1.6-1.8 and 7.LS3.1-3.3)
    - Superhero Origin Stories folder with student journal, handouts, and other resources
- Why Do Lucy and Maria Who Are Twins Look So Different?
- Twin Teens: One Black, One White, Celebrate Their Differences (video)
- The Twins with Different Skin Color (performance task/assessment used with 7.LS3.1 and 7.LS3.3)
- Amoeba Sisters—Mitosis vs. Meiosis: Side by Side Comparison (video)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 271A-G<br>SE: 268-271 | 5.LS3.2 Provide evidence and analyze data that plants and animals have traits inherited from parents and that |

| Content to Explore | | |
|---|---|---|
| mitosis | meiosis | variations of these traits exist in a group of similar organisms. |
| gametes | cross over | |

| | |
|---|---|
| 7.LS3.3 | Predict the probability of individual dominant and recessive alleles to be transmitted from each parent to offspring during sexual reproduction and represent the genotypic and phenotypic patterns using ratios. |

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

Meiosis produces sex cells that must be combined during fertilization to result in an offspring. Models such as Punnett squares are tools that can be used to make sense of the possible genetic combinations that could arise for a single trait (at this level).

Meiosis produces eggs and sperm, whose chromosomal content is represented symbolically (often letters). Students could project forward from a set of parent genes, prior to meiosis, into the sex cells represented symbolically on the Punnett square. Each square within the predictive field of the Punnett square represents a possible outcome of fertilization.

The cells created during fertilization will have a certain combination of genes (genotype) that will encode for certain proteins. The production of these proteins from genes will control the observable characteristics (structural, functional, behavioral) in the offspring. These observable characteristics are referred to as the organism's phenotype.

**Learning Targets - DCIs**
*Heredity*

1. Dominant genes have more protein, so they are more likely to be expressed or that phenotype is shown. Recessive genes have less protein, so that phenotype is only seen when TWO recessive alleles are present.
2. Genotype is the certain combination of genes in cells created during fertilization that will encode for certain proteins (e.g. homozygous dominant – AA, homozygous recessive – aa, heterozygous – Aa).
3. The production of proteins from genes will control the observable characteristics in offspring referred to as phenotype.
4. Punnett squares can be used to predict genotype and phenotype of offspring from sexual reproduction.
5. Punnett squares predict genetic probability in offspring and each square represents 25% chance of each genotype being expressed. This probability can be expressed in ratios as well.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Use a Punnett square (model) to construct an explanation for how traits are passed from parent to offspring highlighting the genotypic and phenotypic patterns.
2. Use mathematical and computational thinking to show the probability of dominant and recessive alleles transmitted during sexual reproduction highlighting the genotypic and phenotypic patterns using ratios.
3. Analyze and interpret data to predict the probability of a trait being expressed based on the alleles that have been crossed and justify the prediction citing evidence from the Punnett square.
4. Given the probability of genotypes and phenotypes produced by a genetic cross, construct a scientific explanation concluding which trait is dominant and which is recessive.

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

| Anchoring: | Investigative: |
|---|---|
| • Superheroes and real-life superbeings have special abilities.<br>• The seemingly unrelated ladies in this image are not just related but are twins.<br>• The Fugates of Kentucky have skin bluer than Lake Louise.<br>• Some organisms, like the starfish, can reproduce both sexually and asexually. | • Ernest Hemingway was given a six-toed cat that his son named Snow White.<br>• Thailand's Moken people have incredibly clear underwater vision.<br>• Apples come in a variety of colors and taste different. |

**Lesson Resources**

- ***NEW!*** Superhero Origin Stories Teacher Guide (storyline unit taught with superhero anchoring phenomenon and standards 7.LS1.6-1.8 and 7.LS3.1-3.3)
    - Superhero Origin Stories folder with student journal, handouts, and other resources
- Why Do Lucy and Maria Who Are Twins Look So Different?
- Twin Teens: One Black, One White, Celebrate Their Differences (video)
- The Twins with Different Skin Color (performance task/assessment used with 7.LS3.1 and 7.LS3.2)
- The True Story of the Blue People of Kentucky (article)
- Telomeres and Starfish (lesson goes with starfish anchoring phenomenon and standard 7.LS1.7)
- Apple Genetics: A Tasty Phenomenon (investigation goes with the apple investigative phenomenon)
- More Cats with More Toes (performance task/assessment goes with six-toed cat investigative phenomenon)
- Basic Genetics
- What are Traits? (video)
- Bikini Bottom Genetics
- Genetics in Harry Potter's World: Lesson 1
- How Mendel's Pea Plants Helped Us Understand Genetics (video)
- Geniventure
- Genigames
- Geniverse Lab

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 300A-B; 305A-G<br>SE: 300-305 | 5.LS3.1 Distinguish between inherited characteristics and those characteristics that result from a direct interaction with the environment. Apply this concept by giving examples of characteristics of living organisms that are influenced by both inheritance and the environment.<br><br>5.LS3.2 Provide evidence and analyze data that plants and animals have traits inherited from parents and that variations of these traits exist in a group of similar organisms. |

**Content to Explore**

| | |
|---|---|
| probability | alleles |
| dominant | recessive |
| Punnett square | phenotype |
| genotype | homozygous |
| heterozygous | |

| 7.ESS3.1 | Graphically represent the composition of the atmosphere as a mixture of gases and discuss the potential for atmospheric change. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

The atmosphere is ~78% nitrogen, ~21% oxygen, ~1% argon, water vapor, carbon dioxide, and other trace gases. The services provided by the atmosphere are a product of its microscopic structure. Services range from water cycling, to protecting from high energy radiation, or adding stability to Earth's temperatures.

Students should examine both the major and trace gases making up Earth's atmosphere. Discussions regarding the potential for atmospheric change should center on how natural biogeochemical cycles and human impacts determine its composition. Discussion of atmospheric change should include identification of greenhouse gases and the mechanism by which these gases affect climate change.

**Learning Targets - DCIs**
*Earth and Human Activity*

1. Earth's atmosphere is composed of 78% nitrogen, 21% oxygen, 1% trace gases (argon, water vapor, carbon dioxide, other gases) and can be represented in a pie chart.
2. Natural biogeochemical cycles (nitrogen, carbon, oxygen, water) and human impacts determine the atmosphere's composition.
3. Human behaviors can increase or decrease an amount of a certain gas in the atmosphere including greenhouse gases. If one gas changes, the others will change as a result (good or bad).

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Use mathematical and computational thinking to develop mathematical representations (percentages in a pie chart) to show the composition of the atmosphere as a mixture of gases highlighting the potential for atmospheric change.
2. Construct an explanation of the effect of biogeochemical cycles on the potential change in the composition of the atmosphere.
3. Design a solution to human behaviors outlining the impact of the behavior on the atmosphere (stability and change/cause and effect).

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

| Anchoring: | Investigative: |
|---|---|
| • When a jar is placed under a lit candle, the candle will be extinguished. | • The gases inside out bodies are the same gases released during volcanic eruptions.<br>• The burps and farts of cows can change the atmosphere. |

**Lesson Resources**

- Lesson from TDOE: Analyzing and interpreting data (lesson goes with candle jar anchoring phenomenon)
- Modeling Atmospheric Changes Due to Automobiles (lesson goes with jar anchoring phenomenon and 7.ESS3.2)
- Khan Academy: Intro to biogeochemical cycles
- NASA: The Causes of Climate Change
- How Do Greenhouse Gases Actually Work? (video)
- How Can Farms and Forests Coexist? (video)
- Science Snacks: Our Changing Atmosphere (investigation)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 536-573F<br>SE: 536-573 | 6.ESS3.1 Differentiate between renewable and nonrenewable resources by asking questions about their availability and sustainability. |

**Content to Explore**

| | | |
|---|---|---|
| atmosphere | nitrogen | water vapor |
| oxygen | argon | climate change |
| carbon dioxide | greenhouse gases | |

| 7.ESS3.2 | Engage in a scientific argument through graphing and translating data regarding human activity and climate. |
|---|---|

**TDOE Standard Explanation**
*Taken from the TN Science Standards Reference Document (updated 2019)*

The industrialization of many nations has increased the rate that humans extract resources from the Earth. The processing of natural resources and creation of synthetic materials has changed patterns in global temperatures, including areas not developed or occupied by humans. Examples of changes to natural systems could include changes to timing of migration patterns or life cycles of organisms, or changes to glaciers and arctic ice. The behavior of natural systems can accelerate the effects of human activities. Warming the atmosphere increases the amount of water that can be held in the atmosphere, thus when it does rain, the amount of rainfall will be greater, increasing instances of flooding or heavier snowfalls.

Arguments constructed should cite evidence that correlates changes in the patterns for natural processes with changes in the patterns of human activities. Data sets can include levels of carbon dioxide in the atmosphere, the temperature of the earth, levels of energy use, efficiency of energy use, glacial land areas, ocean water levels, areas of polar ice, and areas of forested land. Human activities include the release of greenhouse gases. Extension of this discussion should address the use of scientific understanding and engineering to drive future decision making.

**Learning Targets - DCIs**
*Earth and Human Activity*

1. The processing of natural resources and creation of synthetic materials has changed patterns in global temperatures and natural systems (i.e. timing and migration patterns, life cycles of organisms, or changes to glaciers and arctic ice).
2. Human behaviors can increase or decrease an amount of a certain gas in the atmosphere including greenhouse gases. If one gas changes, the others will change as a result (good or bad).
3. Human activity such as burning fossil fuels, use of cattle, respiration, deforestation, etc. creates heat-trapping gases resulting in a warmer atmosphere.

**Tasks and Assessments—SEPs & CCCs**
*Each task and assessment correspond with a learning target.*

1. Obtain, evaluate, and communicate information about the impact of human activity and how it affects the stability of the atmosphere.
2. Design a solution to human behaviors outlining the impact of the behavior on the atmosphere (stability and change/cause and effect).
3. Use evidence to engage in argument to show the relationship between human activity and climate change highlighting the patterns in data between human activity and climate change.

**Phenomena—Anchoring & Investigative**
*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

| Anchoring: | Investigative: |
|---|---|
| • When a jar is placed under a lit candle, the candle will be extinguished. | • The amount of $CO_2$ in the atmosphere changes as the seasons change.<br>• Burning fossil fuels is changing the pH of the ocean. |

**Lesson Resources**

- Modeling Atmospheric Changes Due to Automobiles (lesson goes with candle jar anchoring phenomenon and 7.ESS3.1)
- NASA: Climate Change: How Do We Know?
- Mapping Greenhouse Gas Emissions Where You Live (lesson)
- Carbon Through the Seasons (lesson goes with seasons investigative phenomenon)
- Getting to the Core: The Link Between Temperature and Carbon Dioxide (lesson)
- Corals and Chemistry (lesson goes with ocean pH investigative phenomenon)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE: 574-599F<br>SE: 574-599 | 6.ESS3.2: Investigate and compare existing and developing technologies that utilize renewable and alternative energy resources.<br><br>6.ESS3.3: Assess the impacts of human activities on the biosphere including conservation, habitat management, species endangerment, and extinction. |
| **Content to Explore** | |
| atmosphere<br>greenhouse gases<br>carbon dioxide<br>climate change | |

| | |
|---|---|
| 7.ETS2.1 | Examine a problem from the medical field pertaining to biomaterials and design a solution taking into consideration the criteria, constraints, and relevant scientific principles of the problem that may limit possible solutions. |

**TDOE Standard Explanation**

*Taken from the TN Science Standards Reference Document (updated 2019)*

Fields such as material sciences depend heavily on the advancement of scientific understanding. The on-going advancement of these fields is pushed by progress in science. The development of new biomaterials also requires consideration for the long-term effects of medical materials that may be used internally, such as heart valves. Finding solutions for material use in the body is difficult. Bioengineers must consider strength, flexibility, durability, and chemical inactivity depending on its role. Students should think about chemical and physical properties of materials and chemical reactivity while engineering design solutions that can be employed to help people with human genetic disorders or mutations.

**Learning Targets - DCIs**

*Links Among Engineering, Technology, Science, and Society*

1. In the event of a medical problem or genetic disorder, scientists and engineers develop solutions for organisms that help them carry out life processes.
2. Biomaterials solve the problems while meeting appropriate criteria and constraints (strength, flexibility, durability, chemical inactivity, physical and chemical properties, and cost effectiveness).

**Tasks and Assessments—SEPs & CCCs**

*Each task and assessment correspond with a learning target.*

1. Construct an explanation about a problem in the medical field and identify the cause to design a solution to reduce or remove the impact on the organism.
2. Design a solution to show understanding of biomaterials and their uses in the medical field highlighting the criteria and constraints that may limit possible solutions (structure and function).

**Phenomena—Anchoring & Investigative**

*Anchoring phenomena- carry through the entire unit; Investigative phenomena- supports the anchoring phenomenon*

| Anchoring: | Investigative: |
|---|---|
| • When M'Kenna was 13, she started losing weight and feeling sick all of the time.<br>• A baby's life was saved with a 3D printed device that restored his breathing. | • A spinach leaf was transformed into beating human heart tissue. |

**Lesson Resources**

- ***UPDATED!*** A Medical Mystery Teacher Guide (storyline unit taught with M'Kenna anchoring phenomenon and standards 7.LS1.1, 1.2, 1.4, 1.5, 1.9, and 7.ETS2.1)
  - A Medical Mystery folder with student journal, handouts, and other resources
- Biomedical Engineering Design Solution (investigation goes with 3D printed device anchoring phenomenon and standards 7.LS1.5 and 7.LS3.1)
- Engineering Solutions to Biomedical Problems (article)
- Broken Bones and Biomedical Materials (engineering challenge)

| Textbook Connections | Previous Standard(s) |
|---|---|
| TE:442-535H<br>SE:442-535 | 5.ETS2.3 Identify how scientific discoveries lead to new and improved technologies.<br><br>4.ETS2.2 Determine the effectiveness of multiple solutions to a design problem given the criteria and the constraints.<br><br>4.ETS2.3 Explain how engineers have improved existing technologies to increase their benefits, to decrease known risks, and to meet societal demands (artificial limbs, seatbelts, cell phones). |

**Content to Explore**

| | |
|---|---|
| biomaterials | criteria |
| constraints | biomedical engineering |