



**Approved by the Mississippi State Board of Education**

**July 25, 2008**

# Mississippi Science Framework

## 2010



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**July 25, 2008**

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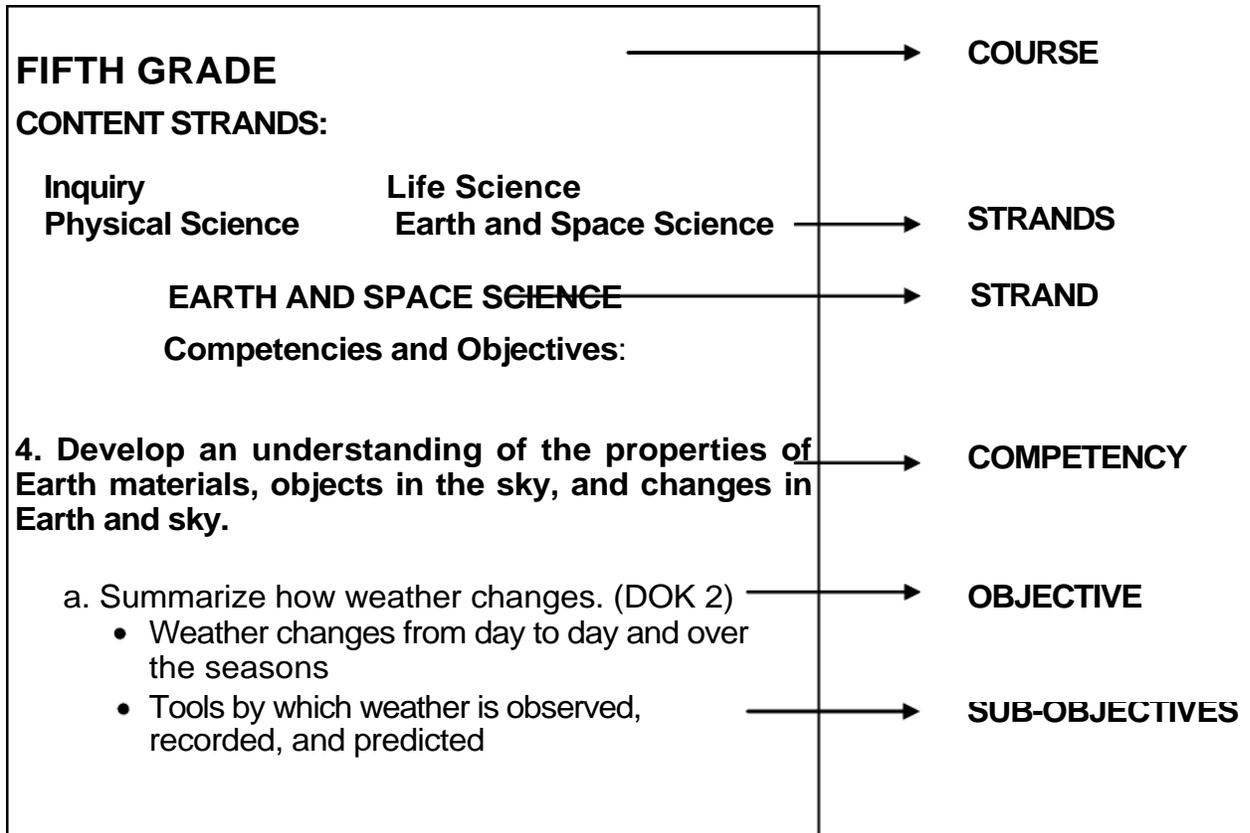
The Mississippi Department of Education is dedicated to student success including the improvement of student achievement in science in order to produce citizens who are capable of making complex decisions, solving complex problems, and communicating fluently in a technological society. Through the utilization of the *2010 Mississippi Science Framework*, teachers will challenge their students to think more deeply about the science content, thus improving student understanding of science. This document is based on premises that all children can learn, and that high expectations produce high achievement.

## **PURPOSE**

The primary purpose of the *2010 Mississippi Science Framework* is to provide a basis for curriculum development for K-12 teachers. The framework provides an outline of what students should learn through competencies and objectives. The *2010 Mississippi Science Framework* replaces the *2001 Mississippi Science Framework*. The content of the framework is centered on the strands of **inquiry, physical science, life science, and Earth and space science**. Instruction in these areas is designed to expose students to experiences which reflect how science should be valued, to enhance students' confidence in their ability to apply scientific processes, and to help students learn to communicate and reason scientifically. The *2010 Mississippi Science Framework* provides teachers with the systematic progression across grade levels and is written to ensure the development of essential science concepts that students will utilize as they pursue a career or continue their education.

## ORGANIZATION

The *2010 Mississippi Science Framework* is organized by grade level (grades K-8) and by course at the secondary level (grades 9-12). A general description that includes the purpose, overview, and suggested prerequisites is found preceding each curriculum outline for the grade level or course. The curriculum outline for the *2010 Mississippi Science Framework* is formatted as follows:



## STRANDS

The *2010 Mississippi Science Framework* is comprised of three content strands: **Life Science, Earth and Space Science, and Physical Science**. The five process strands are **Science as Inquiry, Unifying Concepts and Processes, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science**. The three content strands along with the five process strands combine to provide continuity to the teaching of K-12 science. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum. The content strands and process strands overlap and should be integrated and embedded throughout teachers' daily lesson plans.

**Inquiry** is listed as a separate strand in order to place emphasis on developing the ability to ask questions, observe, experiment, measure, problem solve/reason, use tools of science, gather data, and communicate findings. **Inquiry is not an isolated unit of instruction and must be embedded throughout the content strands.**

**Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop an understanding of scientific ideas, as well as an understanding of how scientists study the natural world. *National Science Education Standards*, p. 23.**

## COMPETENCIES

The competencies, printed in bold face type, are the part of the framework that is required to be taught to all students. The **Elementary/Middle School Science Test and Biology I Subject Area Test are aligned to the competencies. Competencies do not have to be taught in the order presented in the framework.** The competencies are presented in outline form for consistency and for easy reference throughout the framework. Competencies are intentionally broad in order to allow school districts and teachers the flexibility to create a curriculum that meets the needs of their students. They may relate to one, many, or all of the science framework strands and may be combined and taught with other competencies throughout the school year. Competencies provide a general guideline of on-going instruction, not isolated units, activities, or skills. The competencies are not intended to be a list of content skills that are taught and recorded as "mastered."

## OBJECTIVES

The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that **objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.** The Elementary/Middle School Science Test and Biology I Subject Area Test will be developed based on the objectives found in the framework. At least fifty percent (50%) of the test items on the Elementary/Middle School Science Test and Biology I Subject Area Test must match the Depth of Knowledge (DOK) level assigned to the objectives for each competency. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

## DEPTH OF KNOWLEDGE

Each objective for the *2010 Mississippi Science Framework* has been assigned a Depth of Knowledge (DOK) level based on the work of Dr. Norman L. Webb. DOK levels help administrators, teachers, and parents understand the objective in terms of the complexity of what students are expected to know and do. Standards (i.e., competencies and objectives) vary in terms of complexity. Some objectives expect students to reproduce a fact or complete a sequence of steps, while others expect students to reason, extend their thinking, synthesize information from multiple sources, and produce significant work over time. Teachers must know what level of complexity is required by an objective in order to ensure that students have received prior instruction or have had an opportunity to learn content at the level students will be expected to demonstrate or perform. Assessment items must be created to ensure that what is elicited from students on the assessment is as demanding cognitively as what students are expected to know and do as stated in the objectives.

Four levels of Depth of Knowledge (DOK) are used in the *2010 Mississippi Science Framework*. The levels represent a hierarchy based on two main factors. (1) One factor is sophistication and complexity. Sophistication will depend on the abstractness of the activity, the degree to which simple knowledge and skills have to be recalled or drawn upon, the amount of cognitive processing required, the complexity of the content concepts used, the amount of content that has to be recalled or drawn upon, the lack of routine, and the need to extend knowledge meaningfully or produce novel findings. (2) The other factor is that students at the grade level tested have received prior instruction or have had an opportunity to learn the content. Objectives and assessment items that address complex knowledge can still have a low DOK level if the required knowledge is commonly known and students with normal instruction at a grade level should have had the opportunity to learn how to routinely (habitually) perform what is being asked.

The four levels of Depth of Knowledge (DOK) are described below.

**Levels:**

**Level 1 (Recall)** includes the recall of information such as a fact, definition, term, or a simple procedure, as well as performing a simple algorithm or applying a formula. Other key words that signify a Level 1 include “identify,” “recall,” “recognize,” “use,” and “measure.” Verbs such as “describe” and “explain” could be classified at different levels depending on what is to be described and explained.

**Level 2 (Skill/Concept)** includes the engagement of some mental processing beyond a habitual response. A level 2 assessment item requires students to make some decisions as to how to approach the problem or activity, whereas Level 1 requires students to demonstrate a rote response, perform a well-known algorithm, follow a set procedure (like a recipe), or perform a clearly defined series of steps. Keywords that generally distinguish a Level 2 item include “classify,” “organize,” “estimate,” “make observations,” “collect and display data,” and “compare data.” These actions imply more than one step. For example, to compare data requires first identifying characteristics of the objects or phenomenon and then grouping or ordering the objects. Some action verbs, such as “explain,” “describe,” or “interpret” could be classified at different levels depending on the object of the action. For example, if an item required students to explain how light affects mass by indicating there is a relationship between light and heat, this is considered a Level 2. Interpreting information from a simple graph, requiring reading information from the graph, also is a Level 2. Interpreting information from a complex graph that requires some decisions on what features of the graph need to be considered and how information from the graph can be aggregated is a level 3. Caution is warranted in interpreting Level 2 as only skills because some reviewers will interpret skills very narrowly, as primarily numerical skills, and such interpretation excludes from this level other skills such as visualization skills and probability skills, which may be more complex simply because they are less common. Other Level 2 activities include explaining the purpose and use of experimental procedures; carrying out experimental procedures; making observations and collecting data; classifying, organizing, and comparing data; and organizing and displaying data in tables, graphs, and charts.

**Level 3 (Strategic Thinking)** requires reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. In most instances, requiring students to explain their thinking is a Level 3. Activities that require students to make conjectures are also at this level. The cognitive demands at Level 3 are complex and abstract. The complexity does not result from the fact that there are multiple answers, a possibility for both levels 1 and 2, but because the task requires more demanding reasoning. An activity, however, that has more than one possible answer and requires students to justify the response they give would most likely be a Level 3. Other Level 3 activities include drawing conclusions from observations; citing evidence and developing a logical argument for concepts; explaining phenomena in terms of concepts; and using concepts to solve problems.

**Level 4 (Extended Thinking)** requires complex reasoning, planning, developing, and thinking most likely over an extended period of time. The extended time period is not a distinguishing factor if the required work is only repetitive and does not require applying significant conceptual understanding and high-order thinking. For example, if a student has to take the water temperature from a river each day for a month and then construct a graph, this would be classified as a Level 2. However, if the student is to conduct a river study that requires taking into consideration a number of variables, this would be a Level 4. At Level 4, the cognitive demands of the task should be high and the work should be very complex. Students should be required to make several connections - relate ideas within the content area or among content areas - and have to select one approach among many alternatives on how the situation should be solved, in order to be at this highest level. Level 4 activities include designing and conducting experiments; making connections between a finding and related concepts and phenomena; combining and synthesizing ideas into new concepts; and critiquing experimental designs.

## THE REVISION PROCESS FOR THE SCIENCE FRAMEWORK

From nominations by school district superintendents and others, the Mississippi Science Curriculum Writing Team was selected in July 2005. The purpose of the team was to draft a new science framework. The team was composed of teachers, administrators, and university professors throughout Mississippi.

In order to gain a sufficient understanding of the direction of science education, the writing team reviewed the *National Science Education Standards, Benchmarks for Science Literacy*, the *Science Framework for the 2010 National Assessment of Educational Progress (NAEP)*, current literature, and research. These resources served as a foundation for the development of the framework.

The Mississippi Department of Education solicited comment from the Norman Webb Group and other outside evaluators to assure a vertical flow of science with emphasis on rigorous science content and alignment with national standards.

## CYCLE

All Mississippi content area frameworks are revised on a six-year cycle. Approximately three years after a framework is implemented, a writing team is selected to review the current framework and make modifications based on best practices in the teaching of content areas as reflected in state and national trends. The revision process is approximately two years.

The pilot (optional) years for the *2010 Mississippi Science Framework* are school years 2008-2010. The implementation (required) year for the framework is school year 2010-2011.

## SEQUENCE

Students will progress according to grade level through the eighth grade. Course sequence options are available to students in grades 9-12. Below are some proposed secondary course sequence options:

### *Proposed Secondary Course Sequence Options*

<b>Grade Level</b>	<b>OPTION 1</b>	<b>OPTION 2</b>	<b>OPTION 3</b>	<b>OPTION 4</b>
9	Physical Science	Biology I	Biology I	Elective
10	Biology I	Chemistry	Elective	Biology I
11	Earth Science	Physics	Elective	Elective
12	Elective	Elective	Elective	Elective

### Laboratory-based Science Courses

The *2010 Mississippi Science Framework* is designed so that all science courses function as laboratory-based courses. A laboratory-based course is one in which 20% of the instructional time is spent in laboratory experiences. “A school laboratory investigation (also referred to as a lab) is defined as an experience in the laboratory, classroom, or the field that provides students with opportunities to interact directly with natural phenomena or with data collected by others using tools, materials, data collection techniques, and models.” (National Research Council, 2006, p. 3)

Lab-based **Physical Science** Courses are distinguished as follows:

Physical Science  
 Chemistry  
 Physics  
 AP Chemistry  
 AP Physics B  
 AP Physics C – Electricity and Magnetism  
 AP Physics C – Mechanics

## Science Courses and Electives

The following secondary science courses and electives are included in the *2010 Mississippi Science Framework*:

<b>Strand</b>	<b>Course</b>	<b>Carnegie Unit</b>
<b>Physical Science</b>	Physical Science	1
	Physics	1
	Chemistry	1
	Organic Chemistry	0.5
<b>Life Science</b>	Introduction to Biology	1
	Biology I	1
	Biology II	1
	Genetics	0.5
	Microbiology	0.5
	Botany	0.5
	Zoology	0.5
	Marine and Aquatic Science	0.5
	Human Anatomy and Physiology	1
Biomedical Research	1	
<b>Earth and Space Science</b>	Earth and Space Science	1
	Environmental Science	0.5
	Geology	0.5
	Astronomy	0.5
	Aerospace Studies	0.5
	Spatial Information Science	0.5 or 1
<b>Other</b>	Field Experiences	0.5

## CHANGING EMPHASES

The ~~National Science Education Standards~~ encompass the following changes in emphases:

### LESS EMPHASIS ON

Knowing scientific facts and information

Studying subject matter disciplines (physical, life, Earth science) for their own sake

Separating science knowledge and science process

Covering many science topics

Implementing inquiry as a set of processes

### MORE EMPHASIS ON

Understanding scientific concepts and developing abilities of inquiry

Learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and history and nature of science

Integrating all aspects of science content

Studying a few fundamental science concepts

Implementing inquiry as instructional strategies, abilities, and ideas to be learned

## CHANGING EMPHASES TO PROMOTE INQUIRY

### LESS EMPHASIS ON

Activities that demonstrate and verify science content

Investigations confined to one class period

Process skills out of context

Emphasis on individual process skills such as observation or inference

Getting an answer

Science as exploration and experiment

Individuals and groups of students analyzing and synthesizing data without defending a conclusion

Doing few investigations in order to leave time to cover large amounts of content

Concluding inquiries with the result of the experiment

Management of materials and equipment

Private communication of student ideas and conclusions to teacher

### MORE EMPHASIS ON

Activities that investigate and analyze science questions

Investigations over extended periods of time

Process skills in context

Using multiple process skills - manipulation, cognitive, procedural

Using evidence and strategies for developing or revising an explanation

Science as argument and explanation  
Communicating science explanations

Groups of students often analyzing and synthesizing data after defending conclusions

Doing more investigations in order to develop understanding, ability, values of inquiry and knowledge of science content

Applying the results of experiments

Management of ideas and information

Public communication of student ideas and work to classmates

*Note: Reprinted with permission from National Science Education Standards, 1996*

## COMMITTEE RECOMMENDATIONS

In addition to the curriculum content, the Science Framework Revision Team proposes several recommendations for school districts in Mississippi. The recommendations are as follows:

- 1) Elementary science education is essential. The concepts, principles, processes, and skills must be acquired in order to comprehend what students see, hear, read and interpret. Science at the elementary level can be used to enhance reading comprehension and should be a central, integrated part of elementary education.
- 2) More resources should be available for science teachers. Equipment, computer programs, primary or related documents, and other resources should be a part of a well-rounded science education program. School districts should promote the acquisition of appropriate outstanding educational resources.
- 3) The number of students in lab-based science courses should be limited to twenty-four (24). This makes laboratory activities safer and more meaningful for the student.
- 4) Lab-based science courses should include an average of twenty percent (20%) of instructional time for active laboratory activities. Those teachers should be allotted additional planning time to prepare for these essential activities.

## KINDERGARTEN

*Kindergarten* is the foundation for all other formal learning experiences. Students explore living/non-living things, the five senses, nutrition, magnets, matter, nonstandard units of measurement, graphs, the Earth, and environmental concerns. The focus is hands-on science, inquiry, self-discovery, cooperative learning, communication, and lifelong learning.

The *Mississippi Science Framework* is comprised of three content strands: **Life Science, Earth and Space Science, and Physical Science**. The five process strands are **Science as Inquiry, Unifying Concepts and Processes, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science**. The three content strands, along with the five process strands, combine to provide continuity to the teaching of K-12 science. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum. **Science as Inquiry** is listed as a separate strand in order to place emphasis on developing the ability to ask questions, to observe, to experiment, to measure, to problem solve, to gather data, and to communicate findings. **Inquiry is not an isolated unit of instruction and must be embedded throughout the content strands.**

**The competencies, printed in bold face type, are the part of the framework that is required to be taught to all students. The Elementary/Middle School Science Tests and Biology I Subject Area Test are aligned to the competencies. Competencies do not have to be taught in the order presented in the framework.** The competencies are presented in outline form for consistency and easy reference throughout the framework. Competencies are intentionally broad in order to allow school districts and teachers the flexibility to create a curriculum that meets the needs of their students. They may relate to one, many, or all of the science framework strands and may be combined and taught with other competencies throughout the school year. Competencies provide a guideline of on-going instruction, not isolated units, activities, or skills. The competencies are not intended to be a list of content skills that are taught and recorded as “mastered.”

The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

The Elementary/Middle School Science Test and Biology I Subject Area Test will be developed based on the objectives found in the framework. At least fifty percent (50%) of the test items on the Elementary/Middle School Science Test must match the Depth of Knowledge (DOK) level assigned to the objectives for each competency. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

# KINDERGARTEN

## CONTENT STRANDS:

Inquiry  
Physical Science

Life Science  
Earth and Space Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Ask questions and find answers by scientific investigation.

- a. Demonstrate an understanding of a simple investigation by asking questions. (DOK 2)
- b. Compare, sort, and group objects according to size, shape, color, and texture. (DOK 2)
- c. Identify simple tools (rulers, thermometers, scales, and hand lenses) used to gather information. (DOK 1)
- d. Recognize that people have always had questions about their world and identify science as one way of answering questions and explaining the natural world. (DOK 1)
- e. Describe ideas using drawings and oral expression. (DOK 2)
- f. Recognize that when a science investigation is done the way it was done before, very similar results are expected. (DOK 1)

### PHYSICAL SCIENCE

#### 2. Identify properties of objects and materials, position and motion of objects, and properties of magnetism.

- a. Classify properties of objects and materials according to their observable characteristics. (DOK 2)
  - Materials (e.g., wood, paper, plastic, metal)
  - Matter (solid or liquid)
  - Objects that sink or float in water
- b. Differentiate what happens to water left in an open container (disappears) and water left in a closed container (remains). (DOK 1)
- c. Compare types of forces and motion. (DOK 1)
  - External motion of objects (e.g., straight-line, circular, back-and-forth, rotational)
  - Internal motion of objects (e.g., bending, stretching)

- d. Compare the interaction between two magnets and the interaction between magnets and other objects (e.g., iron, other metals, wood, water). (DOK 1)

## LIFE SCIENCE

### 3. Understand characteristics, structures, life cycles, and environments of organisms.

- a. Group animals and plants by their physical features (e.g., size, appearance, color). (DOK 2)
- b. Compare and contrast physical characteristics of humans. (DOK1) The five senses (sight, smell, touch, taste, hearing) and corresponding body parts  
The six major body organs (brain, skin, heart, lungs, stomach, intestines).
- c. Classify parts of the human body that help it seek, find, and take in food when it feels hunger. (DOK 1)

Eyes and nose for detecting food

- Legs to get it
  - Arms to carry it away
  - Mouth to eat it
- d. Identify offspring that resemble their parents. (DOK 1)
- e. Recognize and compare the differences between living organisms and non-living materials. (DOK 2)

## EARTH AND SPACE SCIENCE

### 4. Understand properties of Earth materials, objects in the sky, and changes in Earth and sky.

- a. Sort, separate, and classify Earth materials (e.g., clay, silt, sand, pebbles, gravel) using various strategies. (DOK 2)
- b. Identify and describe properties of Earth materials (soil, rocks, water, and air). (DOK 1)
- c. Collect and display local weather data. (DOK 2)
- d. Describe ways to conserve water. (DOK 2)
- e. Describe the effects of the sun on living and non-living things. (DOK 1)

Warms the land, air, and water

- Helps plants grow
- f. Identify the sun as Earth's source of light and heat and describe changes in shadows over time. (DOK 2)

## FIRST GRADE

The *First Grade* competencies and objectives are an extension of the Kindergarten concepts. Students explore patterns and diversity of living organisms, the structure of the solar system, the diversity of Earth's surface, changes in the Earth's atmosphere, environmental concerns, changes in matter, and measurement. Students begin to develop an understanding of the nature of science and scientific knowledge using hands-on science activities and inquiry-based learning, communication, and life-long learning.

The *Mississippi Science Framework* is comprised of three content strands: **Life Science, Earth and Space Science, and Physical Science**. The five process strands are **Science as Inquiry, Unifying Concepts and Processes, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science**. The three content strands, along with the five process strands, combine to provide continuity to the teaching of K-12 science. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum. **Science as Inquiry** is listed as a separate strand in order to place emphasis on developing the ability to ask questions, to observe, to experiment, to measure, to problem solve, to gather data, and to communicate findings. **Inquiry is not an isolated unit of instruction and must be embedded throughout the content strands.**

**The competencies, printed in bold face type, are the part of the framework that is required to be taught to all students. The Elementary/Middle School Science Tests and Biology I Subject Area Test are aligned to the competencies. Competencies do not have to be taught in the order presented in the framework.** The competencies are presented in outline form for consistency and easy reference throughout the framework. Competencies are intentionally broad in order to allow school districts and teachers the flexibility to create a curriculum that meets the needs of their students. They may relate to one, many, or all of the science framework strands and may be combined and taught with other competencies throughout the school year. Competencies provide a guideline of on-going instruction, not isolated units, activities, or skills. The competencies are not intended to be a list of content skills that are taught and recorded as "mastered."

The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

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# FIRST GRADE

## CONTENT STRANDS:

Inquiry  
Physical Science

Life Science  
Earth and Space Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Understand how to plan and carry out a simple scientific investigation.

- a. Demonstrate an understanding of a simple investigation by asking appropriate questions about objects, organisms, and events. (DOK 2)
- b. Compare, sort, and group objects according to their attributes. (DOK 2)
- c. Use simple tools (e.g., rulers, scales, hand lenses, thermometers, microscopes) to gather information. (DOK 1)
  - Length, using nonstandard units (e.g., paper clips, Unifix cubes, etc.) and standard units (inches, centimeters)
  - Weight, using a balance scale with and without nonstandard units
  - Capacity, using nonstandard units
- d. Match a simple problem to a technological solution related to the problem (e.g., dull pencil - sharpener, bright light - sunglasses, hot room - fan, cold head - hat, heavy baby - stroller). (DOK 1)
- e. Use diagrams and written and oral expression to describe ideas or data. (DOK 2)
- f. Predict the results of an investigation if it is repeated. (DOK 2)

### PHYSICAL SCIENCE

#### 2. Develop an understanding of properties of objects and materials, position and motion of objects, and properties of heat and magnetism.

- a. Recognize that most things are made of parts. (DOK 1)
- b. Describe properties and changes of objects and materials. (DOK 1)
  - Processes of melting and freezing
  - How water evaporates and disappears into the atmosphere
  - How water condenses onto cold surfaces
- c. Describe the effects of various forms of motion and of forces on objects. (DOK 2)
  - Different forms of motion (sliding, rolling, straight line, circular, back-and-forth)
  - Effects that motion can produce (spilling, breaking, bending)

- d. Differentiate between interactions of two magnets and the interaction of a magnet with objects made of iron, other metals, and nonmetals. (DOK 1)
- e. Describe changes in shadows over time and predict how a shadow will look as the light source moves. (DOK 2)
- f. Compare and classify solids and liquids. (DOK 2)
- g. Identify vibrating objects that produce sound and classify sounds (e.g., high or low pitched, loud or soft). (DOK 1)

## **LIFE SCIENCE**

### **3. Develop an understanding of the characteristics, structures, life cycles, interactions, and environments of organisms.**

- a. Classify animals and plants by observable features (e.g., size, appearance, color, motion, habitat). (DOK 2)
- b. Describe the primary function of the major body organs (brain, skin, heart, lungs, stomach, intestines, bones, and muscles). (DOK 2)
- c. Communicate the importance of food and explain how the body utilizes food. (DOK 2)
- d. Chart and compare the growth and changes of animals from birth to adulthood. (DOK 2)
- e. Identify the basic needs of plants and animals and recognize that plants and animals both need to take in water, animals need food, and plants need light. (DOK 1)
- f. Identify and label the parts of a plant. (DOK 2)

## **EARTH AND SPACE SCIENCE**

### **4. Develop an understanding of the properties of Earth materials, objects in the sky, and changes in Earth and sky.**

- a. Compare and classify Earth materials. (DOK 1)
  - Physical attributes of rocks (e.g., large/small, heavy/light, smooth/rough, hard/crumby, dark/light, etc.)
  - Physical attributes of soil (e.g., smell, texture, color, etc.)
- b. Identify Earth landforms and bodies of water (e.g., continents, islands, peninsulas, oceans, rivers, lakes, ponds, creeks). (DOK 1)
- c. Observe, identify, record, and graph daily weather conditions. (DOK 3)
- d. Categorize types of actions that cause water, air, or land pollution. (DOK 2)
- e. Collect, categorize, and display various ways energy from the sun is used. (DOK 2)
- f. Identify relationships between lights and shadows and illustrate how the shape of the moon changes over time. (DOK 1)
- g. Distinguish characteristics of each season and describe how each season merges into the next. (DOK 1)

## SECOND GRADE

The *Second Grade* science competencies and objectives are an extension of concepts learned in Kindergarten and First Grade. Students explore physical and behavioral characteristics of different species, the diversity of the solar system, changes in the Earth's atmosphere, and the characteristics of sound, light, and color. Students continue to develop an understanding of the nature of science and scientific knowledge through hands-on science activities, inquiry-based learning, cooperative learning, and scientific communication.

The *Mississippi Science Framework* is comprised of three content strands: **Life Science, Earth and Space Science, and Physical Science**. The five process strands are **Science as Inquiry, Unifying Concepts and Processes, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science**. The three content strands, along with the five process strands, combine to provide continuity to the teaching of K-12 science. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum. **Science as Inquiry** is listed as a separate strand in order to place emphasis on developing the ability to ask questions, to observe, to experiment, to measure, to problem solve, to gather data, and to communicate findings. **Inquiry is not an isolated unit of instruction and must be embedded throughout the content strands.**

**The competencies, printed in bold face type, are the part of the framework that is required to be taught to all students. The Elementary/Middle School Science Tests and Biology I Subject Area Test are aligned to the competencies. Competencies do not have to be taught in the order presented in the framework.** The competencies are presented in outline form for consistency and easy reference throughout the framework. Competencies are intentionally broad in order to allow school districts and teachers the flexibility to create a curriculum that meets the needs of their students. They may relate to one, many, or all of the science framework strands and may be combined and taught with other competencies throughout the school year. Competencies provide a guideline of on-going instruction, not isolated units, activities, or skills. The competencies are not intended to be a list of content skills that are taught and recorded as "mastered."

The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

The Elementary/Middle School Science Test and Biology I Subject Area Test will be developed based on the objectives found in the framework. At least fifty percent (50%) of the test items on the Elementary/Middle School Science Test must match the Depth of Knowledge (DOK) level assigned to the objectives for each competency. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

## SECOND GRADE

### CONTENT STRANDS:

Inquiry

Physical Science

Life Science

Earth and Space Science

### COMPETENCIES AND OBJECTIVES:

#### INQUIRY

##### 1. Develop abilities necessary to conduct scientific investigations.

- a. Formulate questions about objects and organisms and predict outcomes in order to conduct a simple investigation. (DOK 2)
- b. Compare, sort, and group objects according to two or more attributes. (DOK 2)
- c. Use simple tools (e.g., rulers, thermometers, scales, hand lenses, microscopes, balances, clocks) to gather information. (DOK 1)
  - Length, to the nearest inch, foot, yard, centimeter, and meter
  - Capacity, to the nearest ounce, cup, pint, quart, gallon, and liter
  - Weight, to the nearest ounce, pound, gram, and kilogram
  - Time, to the nearest hour, half-hour, quarter-hour, and five-minute intervals (using digital and analog clocks)
- d. Collect and display technological products (e.g., zipper, coat hook, ceiling fan pull chain, can opener, bridge, apple peeler, wheel barrow, nut cracker, etc.) to determine their function. (DOK 1)
- e. Create line graphs, bar graphs, and pictographs to communicate data. (DOK 2)
- f. Infer that science investigations generally work the same way in different places. (DOK 2)

#### PHYSICAL SCIENCE

##### 2. Apply an understanding of properties of objects and materials, position and motion of objects, and properties of magnetism.

- a. Investigate to conclude that when water changes to ice and then melts, the amount of water is the same as it was before freezing. (DOK 2)

- b. Investigate and describe properties and changes of matter. (DOK 2) Unique
  - properties of states of matter (Gases are easily compressed while solids and liquids are not; the shape of a solid is independent of its container; liquids and gases take the shape of their containers.) Physical changes (e.g., boiling liquids, freezing ice, tearing paper) Chemical changes (e.g., burning wood, making ice cream, cooking an egg)
- c. Describe observable effects of forces, including buoyancy, gravity, and magnetism. (DOK1)
- d. Classify materials that are or are not attracted to magnets and cite examples of useful magnetic tools in everyday living (e.g., can opener, compass, refrigerator door seal). (DOK 2)
- e. Recognize that an object can be seen only if either light falls on it or it emits light, and that color is a property of light. (DOK 1)
- f. Compare and classify solids, liquids, and gasses. (DOK 2)
- g. Identify vibration as the source of sound and categorize different types of media (e.g., wood, plastic, water, air, metal, glass) according to how easily vibrations travel. (DOK 2)

## LIFE SCIENCE

### 3. Develop and demonstrate an understanding of the characteristics, structures, life cycles, and environments of organisms.

- a. Describe and categorize the characteristics of plants and animals. (DOK 2)  
Plant parts (leaves, stems, roots, and flowers)
  - Animals (vertebrates or invertebrates, cold-blooded or warm-blooded)
  - b. Describe the human body systems with their basic functions and major organs (e.g., brain-nervous, bones-skeletal, muscles-muscular). (DOK 1)
- c. Identify the cause/effect relationships when basic needs of plants and animals are met and when they are not met. (DOK 1)
- d. Compare the life cycles of plants and animals. (DOK 2)
- e. Investigate and explain the interdependence of plants and animals. (DOK 2)  
Herbivore, carnivore, or omnivore
  - Predator-prey relationships
  -

## EARTH AND SPACE SCIENCE

### 4. Develop an understanding of the properties of Earth materials, objects in the sky, and changes in Earth and sky.

- a. Categorize different types of Earth materials, (e.g., rocks, minerals, soils, water, atmospheric gases). (DOK 2)
- b. Describe the three layers of the Earth. (DOK 1)

- c. Collect, organize, and graph weather data obtained by using simple weather instruments (wind vane, rain gauge, thermometer) and explain the components of the water cycle. (DOK 2)
- d. Distinguish how actions or events related to the Earth's environment may be harmful or helpful. (DOK 2)
- e. Model and explain the concept of Earth's rotation as it relates to day and night and infer why it is usually cooler at night than in the day. (DOK 2)
- f. Describe characteristics and effects of objects in the universe. (DOK 1)
  - Position of the sun in relation to a fixed object on Earth at various times (day and night)
  - The major characteristics of planets (revolution and rotation periods, size, number of moons)
  - Changes in the appearance of the moon

## THIRD GRADE

The *Third Grade* competencies and objectives are designed to be an extension of those concepts learned in Kindergarten through Second grade. Students explore organisms and systems, changes in Earth's atmosphere and surface, changes in matter, and measurement skills. Students begin to understand and accurately apply appropriate science concepts, principles, laws, and theories in interacting with society and the environment.

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

The Elementary/Middle School Science Test and Biology I Subject Area Test will be developed based on the objectives found in the framework. At least fifty percent (50%) of the test items on the Elementary/Middle School Science Test must match the Depth of Knowledge (DOK) level assigned to the objectives for each competency. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

## THIRD GRADE

### CONTENT STRANDS:

Inquiry

Physical Science

Life Science

Earth and Space Science

### COMPETENCIES AND OBJECTIVES:

#### INQUIRY

##### 1. Apply concepts involved in a scientific investigation.

- a. Identify questions and predict outcomes that can be examined through scientific investigations. (DOK 3)
- b. Describe familiar objects and events using the senses to collect qualitative (e.g., color, size, shape) information. (DOK 1)
- c. Select and use simple tools (e.g., rulers, thermometers, scales, hand lenses, microscopes, calculators, balances, clocks) to gather information. (DOK 1)
  - Length, to the nearest half of an inch, foot, yard, centimeter, and meter
  - Capacity and weight/mass, in English and metric systems
  - Time, to the nearest minute
  - Temperature, to the nearest degree
- d. Draw conclusions and communicate the results of an investigation. (DOK 2)
- e. Communicate data by creating diagrams, charts, tables, and graphs. (DOK 2)
- f. Ask questions and seek answers to explain why different results sometimes occur in repeated investigations. (DOK 2)

#### PHYSICAL SCIENCE

##### 2. Explain concepts related to objects and materials, position and motion of objects, and properties of magnetism.

- a. Investigate to conclude that the weight of an object is always the sum of its parts, regardless of how it is assembled, (e.g., Lego creation/separate blocks, bucket/cups of sand, roll/stacks of pennies, bag/individual potatoes, etc.) (DOK 2)
- b. Explore and identify physical changes of matter, including melting, freezing, boiling, evaporation, and condensation, (DOK 2)
- c. Investigate and describe forces affecting motion in simple machines (lever, wheel and axle, block and tackle, inclined plane, screw.) (DOK 2)
- d. Differentiate between potential and kinetic energy and recognize their conversions. (DOK 2)
  - Potential to kinetic (e.g., winding a clock/clock begins ticking)
  - Kinetic to potential (e.g., roller coaster moving downward/upward to the top of the hill)

- e. Explain how light waves travel (e.g., in a straight line until they strike an object, through transparent and translucent objects, from reflecting and refracting surfaces, at the surface of opaque objects). (DOK 1)
- f. Differentiate the movement of vibrations in waves (e.g., sound and seismic waves), and cite examples to explain that vibrations move through different materials at different speeds. (DOK 1)
- g. Cite evidence to explain why heating or cooling may change the properties of materials (e.g., boiling an egg, evaporating water, chilling gelatin, making ice cream, etc.) (DOK 2)

## **LIFE SCIENCE**

### **3. Describe the characteristics, structures, life cycles, and environments of organisms.**

- a. Research and explain diverse life forms (including vertebrates and invertebrates) that live in different environments (e.g., deserts, tundras, forests, grasslands, taigas, wetlands) and the structures that serve different functions in their survival (e.g., methods of movement, defense, camouflage). (DOK 2)
- b. Identify and describe the purpose of the digestive, nervous, skeletal, and muscular systems of the body. (DOK 1)
- c. Investigate the relationships between the basic needs of different organisms and discern how adaptations enable an organism to survive in a particular environment. (DOK 2)
- d. Illustrate how the adult animal will look, when given pictures of young animals (e.g., birds, fish, cats, frogs, caterpillars, etc.) (DOK 2)
- e. Recall that organisms can survive only when in environments (deserts, tundras, forests, grasslands, taigas, wetlands) in which their needs are met and interpret the interdependency of plants and animals within a food chain, including producer, consumer, decomposer, herbivore, carnivore, omnivore, predator, and prey. (DOK 2)
- f. Recognize that cells vary greatly in size, structure, and function, and that some cells and tiny organisms can be seen only with a microscope. (DOK 1)

## **EARTH AND SPACE SCIENCE**

### **4. Develop an understanding of the properties of Earth materials, objects in the sky, and changes in Earth and sky.**

- a. Recall that soil is made up of various materials (weathered rock, minerals, plant and animal remains, living organisms.) (DOK 1)
- b. Compare and contrast changes in the Earth's surface that are due to slow processes (erosion, weathering, mountain building) and rapid processes (landslides, volcanic eruptions, earthquakes, floods, asteroid collisions). (DOK 2)

- c. Gather and display local weather information such as temperature, precipitation, clouds, etc., on graphs and use graphs of weather patterns to predict weather conditions. (DOK 3)
    - Instruments (wind vane, rain gauge, thermometers, anemometers, and barometers)
    - Cloud types (cirrus, stratus, cumulus)
    - Water cycle (evaporation, precipitation, condensation)
  - d. Identify the causes and effects of various types of air, land, and water pollution and infer ways to protect the environment. (DOK 3)
  - e. Identify patterns in the phases of the moon, describe their sequence, and predict the next phase viewed in the night sky. (DOK 1)
  - f. Describe the different components of the solar system (sun, planets, moon, asteroids, comets.) (DOK 1)
    - Gravitational attraction of the sun
    - Phases of the moon
    - Constellations
  - g. Explain how fossil records are used to learn about the past, identify characteristics of selected fossils, and describe why they may be found in many places. (DOK 2)
- The Earth Science Museum at the Petrified Forest in Flora, MS The Natural
- Science Museum in Jackson, MS
  -

## FOURTH GRADE

The *Fourth Grade* competencies and objectives are designed to build on concepts and processes learned in Kindergarten through Third grade. Students explore and investigate the diversity of organisms, environmental concerns, matter, forces, and energy. Students apply their understanding of appropriate science concepts, principles, laws and theories in interacting with society and the environment and use the processes of science in solving problems, making decisions, and furthering understanding.

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

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## FOURTH GRADE

### CONTENT STRANDS:

Inquiry  
Physical Science

Life Science  
Earth and Space Science

### COMPETENCIES AND OBJECTIVES:

#### INQUIRY

##### 1. Explain and use skills necessary to conduct scientific inquiry.

- a. Form hypotheses and predict outcomes of problems to be investigated. (DOK 3)
- b. Use the senses and simple tools to gather qualitative information about objects or events (size, shape, color, texture, sound, position, change). (DOK 1)
- b. Demonstrate the accurate use of simple tools to gather and compare information (DOK 1)
  - Tools (English rulers [to the nearest eighth of an inch], metric rulers [to the nearest centimeter], thermometers, scales, hand lenses, microscopes, balances, clocks, calculators, anemometers, rain gauges)
  - Types of data (height, mass/weight, temperature, length, distance, volume, area, perimeter)
- d. Use simple sketches, diagrams, tables, charts, and writing to draw conclusions and communicate data results. (DOK 2)
- e. Interpret and describe patterns of data using drawings, diagrams, charts, tables, graphs, and maps. (DOK 2)
- f. Explain why scientists and engineers often work in teams with different individuals doing different things that contribute to the results. (DOK 2)
- g. Draw conclusions about important steps (e.g., making observations, asking questions, trying to solve a problem, etc.) that led to inventions and discoveries. (DOK 3)

#### PHYSICAL SCIENCE

##### 2. Use the properties of objects and materials, position and motion of objects, and transfer of energy to develop an understanding of physical science concepts.

- a. Recognize that materials may be composed of parts that are too small to be seen without magnification. (DOK 1)

- b. Distinguish between physical and chemical changes and between objects composed of a single substance from those composed of more than one substance. (DOK 2)
- c. Determine the causes and effects of forces on motion. (DOK 2) Force exerted over
  - a distance causes work to be done and that the result (work) is the product of force and distance
  - Friction on moving objects and actions that increase or decrease friction
  - Momentum and inertia
- d. Explain how energy flowing through an electrical circuit can be converted from electrical energy to light, sound, or heat energy. (DOK1)
  - Parts of an electric circuit and resulting actions when circuits are opened or closed
  - Construction and uses of electromagnets
  - Energy transferred through an electrical circuit to a bulb or bell to its surroundings as light, sound, and heat (thermal) energy
- e. Describe how light behaves (travels in a straight line, is absorbed, reflected, refracted, or appears transparent or translucent). (DOK 1)
- f. Investigate and draw conclusions about the relationship between the rate of vibrating objects and the pitch of the sound. (DOK 3)
- g. Describe how heat flows from a warm object to a cold one and categorize examples of materials that may or may not be used as insulators. (DOK 2)

## LIFE SCIENCE

### 3. Analyze the characteristics, structures, life cycles, and environments of organisms.

- a. Describe the cause and effect relationships that explain the diversity and evolution of organisms over time. (DOK 2)
  - Observable traits due to inherited or environmental adaptations
  - Variations in environment (over time and from place to place)
  - Variations in species as exemplified by fossils
  - Extinction of a species due to insufficient adaptive capability in the face of environmental changes
- b. Classify the organs and functions of the nervous, circulatory, and respiratory systems of the body. (DOK 1)
- c. Compare characteristics of organisms, including growth and development, reproduction, acquisition and use of energy, and response to the environment. (DOK 2)
  - Life cycles of various animals to include complete and incomplete metamorphosis
  - Plant or animal structures that serve different functions in growth, adaptation, and survival
  - Photosynthesis
  -

- d. Distinguish the parts of plants as they relate to sexual reproduction and explain the effects of various actions on the pollination process (e.g., wind, water, insects, adaptations of flowering plants, negative impacts of pesticides). (DOK 2)
- e. Analyze food webs to interpret how energy flows from the sun. (DOK 2)
- f. Describe the structural and functional relationships among the cells of an organism. (DOK 2)

Benefit from cooperating

- Vary greatly in appearance
- Perform very different roles
- 

## EARTH AND SPACE SCIENCE

### 4. Develop an understanding of the properties of Earth materials, objects in the sky, and changes in Earth and sky.

- a. Classify sedimentary, metamorphic, and igneous rocks. (DOK 2)
- b. Compare and contrast Earth's geological features and the changes caused by external forces. (DOK 2)

Bodies of water, beaches, ocean ridges, continental shelves, plateaus, faults, canyons,

- sand dunes, and ice caps
- External forces including heat, wind, and water

- Movement of continental plates

- **c.** Investigate, record, analyze and predict weather by observing, measuring with simple weather instruments (thermometer, anemometer, wind vane, rain gauge, barometer and hygrometer), recording weather data (temperature, precipitation, sky conditions, and weather events), and using past patterns to predict future patterns. (DOK 2)

- d. Describe how human activities have decreased the capacity of the environment to support some life forms. (DOK 2)

- Reducing the amount of forest cover
- Increasing the amount of chemicals released into the atmosphere
- Farming intensively
- **e.** Compare and contrast the seasons and explain why seasons vary

at different locations on Earth. (DOK 2)

- f. Describe objects in the universe including their movement. (DOK 2)

- Physical features of the moon (craters, plains, mountains)
- Appearance and movement of Earth and its moon (e.g., waxing/waning of the moon and lunar/solar eclipses)
- Why a planet can be seen in different constellations (locations) at different times

- g. Summarize the process that results in deposits of fossil fuels and conclude why fossil fuels are classified as nonrenewable resources. (DOK 2)

## FIFTH GRADE

The *Fifth Grade* competencies and objectives build on the *Kindergarten* through *Fourth* grade concepts. Students explore structure and function in living systems, reproduction and heredity, behavior, populations and ecosystems, diversity, and adaptations of organisms. Students also investigate properties and changes of properties in matter, motions, forces, transfer of energy, structure of the Earth system, Earth's history, and Earth in the solar system. Throughout the teaching process, inquiry, safety skills, the scientific method process, measuring, use of scientific equipment, current events, environmental factors, and hands-on activities should be emphasized.

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

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# FIFTH GRADE

## CONTENT STRANDS:

**Inquiry**  
**Physical Science**

**Life Science**  
**Earth and Space Science**

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Develop and demonstrate an understanding of scientific inquiry using process skills.

- a. Form a hypothesis, predict outcomes, and conduct a fair investigation that includes manipulating variables and using experimental controls. (DOK 3)
- b. Distinguish between observations and inferences. (DOK 2)
- c. Use precise measurement in conjunction with simple tools and technology to perform tests and collect data. (DOK 1)
  - Tools (English rulers [to the nearest one-sixteenth of an inch], metric rulers [to the nearest millimeter], thermometers, scales, hand lenses, microscopes, balances, clocks, calculators, anemometers, rain gauges, barometers, hygrometers)
  - Types of data (height, mass, volume, temperature, length, time, distance, volume, perimeter, area)
- d. Organize and interpret data in tables and graphs to construct explanations and draw conclusions. (DOK 2)
- e. Use drawings, tables, graphs, and written and oral language to describe objects and explain ideas and actions. (DOK 2)
- f. Make and compare different proposals when designing a solution or product. (DOK 2)
- g. Evaluate results of different data (whether trivial or significant). (DOK 2)
- h. Infer and describe alternate explanations and predictions. (DOK 3)

### PHYSICAL SCIENCE

#### 2. Understand relationships of the properties of objects and materials, position and motion of objects, and transfer of energy to explain the physical world.

- a. Determine how the properties of an object affect how it acts and interacts. (DOK 2)
- b. Differentiate between elements, compounds, and mixtures and between chemical and physical changes (e.g., gas evolves, color, and/or temperature changes). (DOK 2)

- c. Investigate the motion of an object in terms of its position, direction of motion, and speed. (DOK 2)
  - The relative positions and movements of objects using points of reference (distance vs. time of moving objects)
  - Force required to move an object using appropriate devices (e.g., spring scale)
  - Variables that affect speed (e.g., ramp height/length/surface, mass of object)
  - Effects of an unbalanced force on an object's motion in terms of speed and direction
- d. Categorize examples of potential energy as gravitational (e.g., boulder on a hill, child on a slide), elastic (e.g., compressed spring, slingshot, rubber band), or chemical (e.g., unlit match, food). (DOK 2)
- e. Differentiate between the properties of light as reflection, refraction, and absorption. (DOK 1)
  - Image reflected by a plane mirror and a curved-surfaced mirror
  - Light passing through air or water
  - Optical tools such as prisms, lenses, mirrors, and eyeglasses
- f. Describe physical properties of matter (e.g., mass, density, boiling point, freezing point) including mixtures and solutions. (DOK 1)
  - Filtration, sifting, magnetism, evaporation, and flotation
  - Mass, density, boiling point, and freezing point of matter
  - Effects of temperature changes on the solubility of substances
- g. Categorize materials as conductors or insulators and discuss their real life applications (e.g., building construction, clothing, animal covering). (DOK 2)

## LIFE SCIENCE

### 3. Predict characteristics, structures, life cycles, environments, evolution, and diversity of organisms.

- a. Compare and contrast the diversity of organisms due to adaptations to show how organisms have evolved as a result of environmental changes. (DOK 2)
  - Diversity based on kingdoms, phyla, and classes (e.g., internal/external structure, body temperature, size, shape)
  - Adaptations that increase an organism's chances to survive and reproduce in a particular habitat (e.g., cacti needles/leaves, fur/scales) Evidence of
  - fossils as indicators of how life and environmental conditions have changed
    - b. Research and classify the organization of living things. (DOK 2)
      - Differences between plant and animal cells
      - Function of the major parts of body systems (nervous, circulatory, respiratory, digestive, skeletal, muscular) and the ways they support one another
      - Examples of organisms as single-celled or multi-celled
- c. Research and cite evidence of the work of scientists (e.g., Pasteur, Fleming,

- Salk) as it contributed to the discovery and prevention of disease. (DOK 3)
- d. Distinguish between asexual and sexual reproduction. (DOK 1) Asexual
- reproduction processes in plants and fungi (e.g., vegetative propagation in stems, roots, and leaves of plants, budding in yeasts, fruiting bodies in fungi)
  - Asexual cell division (mushroom spores produced/dispersed)
  - Sexual reproduction (e.g., eggs, seeds, fruit)
- e. Give examples of how consumers and producers (carnivores, herbivores, omnivores, and decomposers) are related in food chains and food webs. (DOK 1)

## EARTH AND SPACE SCIENCE

### 4. Develop an understanding of the properties of Earth materials, objects in the sky, and changes in Earth and sky.

- a. Categorize Earth's materials. (DOK 1)
- Rocks, minerals, soils, water, and atmospheric gases
  - Layers of the atmosphere, hydrosphere, and lithosphere
- b. Explain how surface features caused by constructive processes (e.g., depositions, volcanic eruptions, earthquakes) differ from destructive processes (e.g., erosion, weathering, impact of organisms). (DOK 2)
- c. Summarize how weather changes. (DOK 2)
- Weather changes from day to day and over the seasons
  - Tools by which weather is observed, recorded, and predicted
- d. Describe changes caused by humans on the environment and natural resources and cite evidence from research of ways to conserve natural resources in the United States, including (but not limited to) Mississippi. Examples of Mississippi efforts include the following: (DOK 2)
- Associated Physics of America, a private company located in Greenwood Mississippi, develops ways to convert a variety of agricultural products into efficient, environment-friendly and cost-effective energy sources.
  - The Natural Resource Enterprises (NRE) Program of the Department of Wildlife and Fisheries and the Cooperative Extension Service at MSU educate landowners in the Southeast about sustainable natural resource enterprises and compatible habitat management practices.
  - The Engineer Research and Development Center of the Vicksburg District of the U.S. Army Corps of Engineers provides quality engineering and other professional products and services to develop and manage the Nation's water resources, reduce flood damage, and protect the environment.
- e. Predict the movement patterns of the sun, moon, and Earth over a specified time period. (DOK 1)
- f. Compare and contrast the physical characteristics of the planets (e.g., mass, surface gravity, distance from the sun, surface characteristics, moons). (DOK 2)

- g. Conclude that the supply of many Earth resources (e.g., fuels, metals, fresh water, farmland) is limited and critique a plan to extend the use of Earth's resources (e.g., recycling, reuse, renewal). (DOK 3)

## SIXTH GRADE

The *Sixth Grade* competencies and objectives build on the *Kindergarten* through *Fifth* grade concepts and provide foundational skills and knowledge for students to learn core concepts, principles, and theories of science studied in high school courses. Sixth grade science is designed to investigate properties and changes of properties of matter, motions and forces, energy transfer, structure and function in living systems, and the structure of the Earth system. Throughout the teaching process, inquiry, safety skills, the scientific method process, measuring, use of scientific equipment, current events, and hands-on activities should be emphasized.

The *Mississippi Science Framework* is comprised of three content strands: **Life Science, Earth and Space Science, and Physical Science**. The five process strands are **Science as Inquiry, Unifying Concepts and Processes, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science**. The three content strands, along with the five process strands, combine to provide continuity to the teaching of K-12 science. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum. **Science as Inquiry** is listed as a separate strand in order to place emphasis on developing the ability to ask questions, to observe, to experiment, to measure, to problem solve, to gather data, and to communicate findings. **Inquiry is not an isolated unit of instruction and must be embedded throughout the content strands.**

**The competencies, printed in bold face type, are the part of the framework that is required to be taught to all students. The Elementary/Middle School Science Tests and Biology I Subject Area Test are aligned to the competencies. Competencies do not have to be taught in the order presented in the framework.** The competencies are presented in outline form for consistency and easy reference throughout the framework. Competencies are intentionally broad in order to allow school districts and teachers the flexibility to create a curriculum that meets the needs of their students. They may relate to one, many, or all of the science framework strands and may be combined and taught with other competencies throughout the school year. Competencies provide a guideline of on-going instruction, not isolated units, activities, or skills. The competencies are not intended to be a list of content skills that are taught and recorded as “mastered.”

The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

The Elementary/Middle School Science Test and Biology I Subject Area Test will be developed based on the objectives found in the framework. At least fifty percent (50%) of the test items on the Elementary/Middle School Science Test must match the Depth of Knowledge (DOK) level assigned to the objectives for each competency. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

## SIXTH GRADE

### CONTENT STRANDS:

**Inquiry**  
**Physical Science**

**Life Science**  
**Earth and Space Science**

### COMPETENCIES AND OBJECTIVES:

#### INQUIRY

##### 1. Conduct a scientific investigation utilizing appropriate process skills.

- a. Design and conduct an investigation that includes predicting outcomes, using experimental controls, and making inferences. (DOK 3)
- b. Distinguish between qualitative and quantitative observations and make inferences based on observations. (DOK 3)
- c. Use simple tools and resources to gather and compare information (using standard, metric, and non-standard units of measurement). (DOK 1)
  - Tools (e.g., English rulers [to the nearest one-sixteenth of an inch], metric rulers [to the nearest millimeter], thermometers, scales, hand lenses, microscopes, balances, clocks, calculators, anemometers, rain gauges, barometers, hygrometers, telescopes, compasses, spring scales)
  - Types of data (e.g., linear measures, mass, volume, temperature, time, area, perimeter)
  - Resources (e.g., Internet, electronic encyclopedias, journals, community resources, etc.)
- d. Analyze data collected from a scientific investigation to construct explanations and draw conclusions. (DOK 3)
- e. Communicate scientific procedures and conclusions using diagrams, charts, tables, graphs, maps, written explanations, and/or scientific models. (DOK 2)
- f. Evaluate the results or solutions to problems by considering how well a product or design met the challenge to solve a problem. (DOK 3)
- g. Infer explanations for why scientists might draw different conclusions from a given set of data. (DOK 2)
- h. Recognize and analyze alternative explanations and predictions. (DOK 2)

#### PHYSICAL SCIENCE

##### 2. Analyze chemical and physical changes and interactions involving energy and forces that affect motion of objects.

- a. Recognize that atoms of a given element are all alike but atoms of other elements have different atomic structures. (DOK 1)

- b. Distinguish physical properties of matter (e.g., melting points, boiling points, solubility) as it relates to changes in states. (DOK 2)
  - Between solids, liquids, and gases through models that relate matter to particles in motion
  - Solubility in water of various solids to activities (e.g., heating, stirring, shaking, crushing) on the rate of solution
  - Use of solubility differences to identify components of a mixture (e.g., chromatography)
- c. Investigate and describe the effects of forces acting on objects. (DOK 2)
  - Gravity, friction, magnetism, drag, lift, and thrust
  - Forces affecting the motion of objects
- d. Investigate the mechanical and chemical forms of energy and demonstrate the transformations from one form to another. (DOK 2)
  - Energy transformations represented in the use of common household objects
  - Mechanical energy transformed to another form of energy (e.g., vibrations, heat through friction)
  - Chemical energy transformed to another form of energy (e.g., light wands, lightning bugs, batteries, bulbs)
- e. Apply the laws of reflection and refraction to explain everyday phenomena. (DOK 2)
  - Properties of reflection, refraction, transmission, and absorption of light
  - Images formed by plane, convex, and concave lenses and mirrors, and reflecting and refracting telescopes
  - Objects that are opaque, transparent, or translucent
- f. Develop a logical argument to explain how the forces which affect the motion of objects has real-world applications including (but not limited to) examples of Mississippi's contributions as follows: (DOK 3)
  - Automotive industry (Nissan's new production plant is located in Canton, MS. Toyota's new facility is in Tupelo, MS.)
  - Aerospace industry (The Rasmussen Flight Research Laboratory, housed at Mississippi State University, is one of the premier university flight research facilities in the country.)
  - Shipbuilding industry (Ingalls Shipbuilding, of Pascagoula, MS, is a leading supplier of marine vessels to the United States Navy.)
- g. Predict and explain factors that affect the flow of heat in solids, liquids, and gases. (DOK 3)
  - Insulating factors in real life applications (e.g., building, construction, clothing, animal covering)
  - Conduction, convection, or radiation factors used to enhance the flow of heat
  - Temperature differences on the movement of water

## LIFE SCIENCE

### 3. Explain the organization of living things, the flow of matter and energy through ecosystems, the diversity and interactions among populations, and the natural and human-made pressures that impact the environment.

- a. Describe and predict interactions (among and within populations) and the effects of these interactions on population growth to include the effects on available resources. (DOK 2)
  - How cooperation, competition and predation affect population growth
  - Effects of overpopulation within an ecosystem on the amount of resources available
  - How natural selection acts on a population of organisms in a particular environment via enhanced reproductive success
- b. Compare and contrast structure and function in living things to include cells and whole organisms. (DOK 2)
  - Hierarchy of cells, tissues, organs, and organ systems to their functions in an organism
  - Function of plant and animal cell parts (vacuoles, nucleus, cytoplasm, cell membrane, cell wall, chloroplast)
  - Vascular and nonvascular plants, flowering and non-flowering plants, deciduous and coniferous trees
- c. Distinguish between the organization and development of humans to include the effects of disease. (DOK 2)
  - How systems work together (e.g., respiratory, circulatory)
  - Fertilization, early cell division, implantation, embryonic and fetal development, infancy, childhood, adolescence, adulthood, and old age
  - Common diseases caused by microorganisms (e.g., bacteria, viruses, malarial parasites)
- d. Describe and summarize how an egg and sperm unite in the reproduction of angiosperms and gymnosperms. (DOK 1)
  - The path of the sperm cells to the egg cell in the ovary of a flower
  - The structures and functions of parts of a seed in the formation of a plant and of fruits
  - How the combination of sex cells results in a new combination of genetic information different from either parent
- e. Construct a diagram of the path of solar energy through food webs that include humans and explain how the organisms relate to each other. (DOK 2) Autotrophs and heterotrophs, producers, consumers and decomposers Predator/prey relationships, competition, symbiosis, parasitism, commensalisms, mutualism

## **EARTH AND SPACE SCIENCE**

### **4. Establish connections among Earth's layers including the lithosphere, hydrosphere, and atmosphere.**

- a. Compare and contrast the relative positions and components of the Earth's crust (e.g., mantle, liquid and solid core, continental crust, oceanic crust). (DOK 1)
- b. Draw conclusions about historical processes that contribute to the shaping of planet Earth. (DOK 3)
  - Movements of the continents through time
  - Continental plates, subduction zones, trenches, etc.
- c. Analyze climate data to draw conclusions and make predictions. (DOK 2)
- d. Summarize the causes and effects of pollution on people and the environment (e.g., air pollution, ground pollution, chemical pollution) and justify how and why pollution should be minimized. (DOK 1)
- e. Explain the daily and annual changes in the Earth's rotation and revolution. (DOK 2)
  - How the positions of the moon and the sun affect tides
  - The phases of the moon (e.g., new, crescent, half, gibbous, full, waxing, waning)
- f. Differentiate between objects in the universe (e.g., stars, moons, solar systems, asteroids, galaxies). (DOK 1)
- g. Research and cite evidence of current resources in Earth's systems. (DOK 3)
  - Resources such as fuels, metals, fresh water, wetlands, and farmlands
  - Methods being used to extend the use of Earth's resources through recycling, reuse, and renewal
  - Factors that contribute to and result from runoff (e.g., water cycle, groundwater, drainage basin (watershed))

## SEVENTH GRADE

The *Seventh Grade* competencies and objectives build on the Kindergarten through Sixth grade concepts and allow students to make concrete associations using the processes of science in solving problems, making decisions, and furthering understanding. Seventh grade topics include properties and changes of properties of matter, motions and forces, energy transfer, structure and function in living systems, and the structure of the Earth system. Throughout the teaching process, inquiry, safety skills, the scientific method process, measuring, use of scientific equipment, current events, environmental, and hands-on activities should be emphasized.

The *Mississippi Science Framework* is comprised of three content strands: **Life Science, Earth and Space Science, and Physical Science**. The five process strands are **Science as Inquiry, Unifying Concepts and Processes, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science**. The three content strands, along with the five process strands, combine to provide continuity to the teaching of K-12 science. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum. **Science as Inquiry** is listed as a separate strand in order to place emphasis on developing the ability to ask questions, to observe, to experiment, to measure, to problem solve, to gather data, and to communicate findings. **Inquiry is not an isolated unit of instruction and must be embedded throughout the content strands.**

**The competencies, printed in bold face type, are the part of the framework that is required to be taught to all students. The Elementary/Middle School Science Tests and Biology I Subject Area Test are aligned to the competencies. Competencies do not have to be taught in the order presented in the framework.** The competencies are presented in outline form for consistency and easy reference throughout the framework. Competencies are intentionally broad in order to allow school districts and teachers the flexibility to create a curriculum that meets the needs of their students. They may relate to one, many, or all of the science framework strands and may be combined and taught with other competencies throughout the school year. Competencies provide a guideline of on-going instruction, not isolated units, activities, or skills. The competencies are not intended to be a list of content skills that are taught and recorded as “mastered.”

The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

The Elementary/Middle School Science Test and Biology I Subject Area Test will be developed based on the objectives found in the framework. At least fifty percent (50%) of the test items on the Elementary/Middle School Science Test must match the Depth of Knowledge (DOK) level assigned to the objectives for each competency. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

# SEVENTH GRADE

## CONTENT STRANDS:

Inquiry  
Physical Science

Life Science  
Earth and Space Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Design and conduct a scientific investigation utilizing appropriate process skills and technology.

- a. Design, conduct, and draw conclusions from an investigation that includes using experimental controls. (DOK 3)
- b. Discriminate among observations, inferences, and predictions. (DOK 1)
- c. Collect and display data using simple tools and resources to compare information (using standard, metric, and non-standard measurement). (DOK 2)
  - Tools (e.g., English rulers [to the nearest one-sixteenth of an inch], metric rulers [to the nearest millimeter], thermometers, scales, hand lenses, microscopes, balances, clocks, calculators, anemometers, rain gauges, barometers, hygrometers, telescopes, compasses, spring scales, pH indicators, stopwatches)
  - Types of data (e.g., linear measures, mass, volume, temperature, area, perimeter)
  - Resources (e.g., Internet, electronic encyclopedias, journals, community resources, etc.)
- d. Organize data in tables and graphs and analyze data to construct explanations and draw conclusions. (DOK 3)
- e. Communicate results of scientific procedures and explanations through a variety of written and graphic methods. (DOK 2)
- f. Explain how science and technology are reciprocal. (DOK 1)
- g. Develop a logical argument to explain why scientists often review and ask questions about the results of other scientists' work. (DOK 3)
- h. Make relationships between evidence and explanations. (DOK 2)

### PHYSICAL SCIENCE

#### 2. Develop an understanding of chemical and physical changes, interactions involving energy, and forces that affect motion of objects.

- a. Identify patterns (e.g., atomic mass, increasing atomic numbers) and common characteristics (metals, nonmetals, gasses) of elements found in the periodic table of elements. (DOK 2)

- b. Categorize types of chemical changes, including synthesis and decomposition reactions, and classify acids and bases using the pH scale and indicators. (DOK 2)
- c. Compare the force (effort) required to do the same amount of work with and without simple machines (e.g., levers, pulleys, wheel and axle, inclined planes). (DOK 2)
- d. Describe cause and effect relationships of electrical energy. (DOK 2) Energy
  - transfers through an electric circuit (using common pictures and symbols)
  - Electric motor energy transfers (e.g., chemical to electrical to mechanical motion) and generators
  - e. Distinguish how various types of longitudinal and transverse waves (e.g., water, light, sound, seismic) transfer energy. (DOK 2)

Frequency

- Wavelength
- Speed
- Amplitude
- f. Describe the effects of unbalanced forces on the speed or direction of an object's motion. (DOK 2)

Variables that describe position, distance, displacement, speed, and change in speed of

- an object
- Gravity, friction, drag, lift, electric forces, and magnetic forces

## LIFE SCIENCE

### 3. Distinguish the characteristics of living things and explain the interdependency between form and function using the systems of the human organism to illustrate this relationship.

- a. Assess how an organism's chances for survival are influenced by adaptations to its environment. (DOK 2)

The importance of fungi as decomposers

- Major characteristics of land biomes (e.g., tropical rainforests, temperate rainforests, deserts, tundra, coniferous forests/taiga, and deciduous forests)
- Adaptations of various plants to survive and reproduce in different biomes
- b. Classify the organization and development of living things to include prokaryotic (e.g., bacteria) and eukaryotic organisms (e.g., protozoa, certain fungi, multicellular animals and plants). (DOK 2)
- c. Evaluate how health care technology has improved the quality of human life (e.g., computerized tomography [CT], artificial organs, magnetic resonance imaging [MRI], ultrasound). (DOK 3)

- d. Compare and contrast reproduction in terms of the passing of genetic information (DNA) from parent to offspring. (DOK 2)
- Sexual and asexual reproduction
  - Reproduction that accounts for evolutionary adaptability of species
  - Mitosis and meiosis
  - Historical contributions and significance of discoveries of Gregor Mendel and Thomas Hunt Morgan as related to genetics
- e. Compare and contrast how organisms obtain and utilize matter and energy. (DOK 1)
- How organisms use resources, grow, reproduce, maintain stable internal conditions (homeostasis) and recycle waste
  - How plants break down sugar to release stored chemical energy through respiration

## **EARTH AND SPACE SCIENCE**

### **4. Describe the properties and structure of the sun and the moon with respect to the Earth.**

- a. Justify the importance of Earth materials (e.g., rocks, minerals, atmospheric gases, water) to humans. (DOK 3)
- b. Explain the causes and effects of historical processes shaping the planet Earth (e.g., movements of the continents, continental plates, subduction zones, trenches, etc.) (DOK 2)
- c. Describe the causes and effects of heat transfer as it relates to the circulation of ocean currents, atmospheric movement, and global wind patterns (e.g., trade winds, the jet stream). Provide examples of how these global patterns can affect local weather. (DOK 2)
- Characteristics of the Gulf Stream and other large ocean currents
  - Effects on climate in Eastern North America and Western Europe
  - Effects of heat transfer to the movement of air masses, high and low pressure areas, and fronts in the atmosphere
- d. Conclude why factors, such as lack of resources and climate can limit the growth of populations in specific niches in the ecosystem. (DOK 2)
- Abiotic factors that affect population, growth, and size (quantity of light, water, range of temperatures, soil compositions)
  - Cycles of water, carbon, oxygen, and nitrogen in the environment
  - Role of single-celled organisms (e.g., phytoplankton) in the carbon and oxygen cycles

- e. Research and develop a logical argument to support the funding of NASA's Space Programs. (DOK 3)
  - Space exploration (e.g., telescopes, radio telescopes, X-ray telescopes, cameras, spectro-meters, etc.)
  - Spinoffs (e.g., laser, pacemaker, dehydrated food, flame retardant clothing, global positioning system [GPS], satellite imagery, global weather information, diagnostic imagery)
  - Mississippi's contributions to the space industry
- f. Distinguish the structure and movements of objects in the solar system. (DOK 2)
  - Sun's atmosphere (corona, chromosphere, photosphere and core) How phenomena on the sun's surface (e.g., sunspots, prominences, solar wind, solar flares) affect Earth (e.g., auroras, interference in radio and television communication)
  - Eclipses relative to the position of the sun, moon, and Earth
  - Contributions of Copernicus, Galileo, and Kepler in describing the solar system
- g. Research and evaluate the use of renewable and nonrenewable resources and critique efforts in the United States including (but not limited) to Mississippi to conserve natural resources and reduce global warming. (DOK 3)
  - How materials are reused in a continuous cycle in ecosystems, (e.g., Mississippi Ethanol Gasification Project to develop and demonstrate technologies for the conversion of biomass to ethanol)
  - Benefits of solid waste management (reduce, reuse, recycle)
  - Conserving renewable and nonrenewable resources (e.g., The Recycling and Solid Waste Reduction Program in Jackson, MS)
- h. Predict weather events by analyzing clouds, weather maps, satellites, and various data. (DOK 3)

## EIGHTH GRADE

The *Eighth Grade* competencies and objectives build on the Kindergarten through Seventh grade concepts and explore the joint enterprises of science and technology and the interrelationships of these to each other in the context of society and the environment. Eighth grade science is designed to build connections that link technology and societal impacts to topics such as properties and changes of properties of matter, motions and forces, energy transfer, structure and function in living systems, and the structure of the Earth system. Throughout the teaching process, inquiry, safety skills, the scientific method process, measuring, use of scientific equipment, current events, environmental, and hands-on activities should be emphasized.

The *Mississippi Science Framework* is comprised of three content strands: **Life Science, Earth and Space Science, and Physical Science**. The five process strands are **Science as Inquiry, Unifying Concepts and Processes, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science**. The three content strands, along with the five process strands, combine to provide continuity to the teaching of K-12 science. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum. **Science as Inquiry** is listed as a separate strand in order to place emphasis on developing the ability to ask questions, to observe, to experiment, to measure, to problem solve, to gather data, and to communicate findings. **Inquiry is not an isolated unit of instruction and must be embedded throughout the content strands.**

**The competencies, printed in bold face type, are the part of the framework that is required to be taught to all students. The Elementary/Middle School Science Tests and Biology I Subject Area Test are aligned to the competencies. Competencies do not have to be taught in the order presented in the framework.** The competencies are presented in outline form for consistency and easy reference throughout the framework. Competencies are intentionally broad in order to allow school districts and teachers the flexibility to create a curriculum that meets the needs of their students. They may relate to one, many, or all of the science framework strands and may be combined and taught with other competencies throughout the school year. Competencies provide a guideline of on-going instruction, not isolated units, activities, or skills. The competencies are not intended to be a list of content skills that are taught and recorded as “mastered.”

The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

The Elementary/Middle School Science Test and Biology I Subject Area Test will be developed based on the objectives found in the framework. At least fifty percent (50%) of the test items on the Elementary/Middle School Science Test must match the Depth of Knowledge (DOK) level assigned to the objectives for each competency. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

## **Eighth Grade**

### **CONTENT STRANDS:**

**Inquiry**  
**Physical Science**

**Life Science**  
**Earth and Space Science**

### **COMPETENCIES AND OBJECTIVES:**

#### **INQUIRY**

##### **1. Draw conclusions from scientific investigations including controlled experiments.**

- a. Design, conduct, and analyze conclusions from an investigation that includes using experimental controls. (DOK 3)
- b. Distinguish between qualitative and quantitative observations and make inferences based on observations. (DOK 3)
- c. Summarize data to show the cause and effect relationship between qualitative and quantitative observations (using standard, metric, and non-standard units of measurement). (DOK 3)
  - Tools (e.g., English rulers [to the nearest one-sixteenth of an inch], metric rulers [to the nearest millimeter], thermometers, scales, hand lenses, microscopes, balances, clocks, calculators, anemometers, rain gauges, barometers, hygrometers, telescopes, compasses, spring scales, pH indicators, stopwatches, graduated cylinders, medicine droppers)
  - Types of data (e.g., linear measures, mass, volume, temperature, area, perimeter)
  - Resources (e.g., Internet, electronic encyclopedias, journals, community resources, etc.)
- d. Analyze evidence that is used to form explanations and draw conclusions. (DOK 3)
- e. Develop a logical argument defending conclusions of an experimental method. (DOK 3)
- f. Develop a logical argument to explain why perfectly designed solutions do not exist. (DOK 3)
- g. Justify a scientist's need to revise conclusions after encountering new experimental evidence that does not match existing explanations. (DOK 3)
- h. Analyze different ideas and recognize the skepticism of others as part of the scientific process in considering alternative conclusions. (DOK 3)

## PHYSICAL SCIENCE

### 2. Apply concepts relating to an understanding of chemical and physical changes, interactions involving energy, and forces that affect motion of objects.

- a. Identify patterns found in chemical symbols, formulas, reactions, and equations that apply to the law of conservation of mass. (DOK 1)
  - Chemical symbols and chemical formulas of common substances such as NaCl (table salt), H<sub>2</sub>O (water), C<sub>6</sub>H<sub>12</sub>O<sub>6</sub> (sugar), O<sub>2</sub> (oxygen gas), CO<sub>2</sub> (carbon dioxide), and N<sub>2</sub> (nitrogen gas)
  - Mass of reactants before a change and products after a change
  - Balanced chemical equations such as photosynthesis and respiration
- b. Predict the properties and interactions of given elements using the periodic table of the elements. (DOK 2)
  - Metals and nonmetals
  - Acids and bases
  - Chemical changes in matter (e.g., rusting [slow oxidation], combustion [fast oxidation], food spoilage)
- c. Distinguish the motion of an object by its position, direction of motion, speed, and acceleration and represent resulting data in graphic form in order to make a prediction. (DOK 2)
- d. Relate how electrical energy transfers through electric circuits, generators, and power grids, including the importance of contributions from Mississippi companies. (DOK 2)
  - The Electrical Power Products Division of Howard Industries, a leading manufacturer of electrical distribution equipment in such locations as Laurel and Ellisville, MS
  - Kuhlman Electric Corporation, located in Crystal Springs, MS
- e. Contrast various components of the electromagnetic spectrum (e.g., infrared, visible light, ultraviolet) and predict their impacts on living things. (DOK 2)
- f. Recognize Newton's Three Laws of Motion and identify situations that illustrate each law (e.g., inertia, acceleration, action, reaction forces). (DOK 2)

## LIFE SCIENCE

### 3. Compare and contrast the structure and functions of the cell, levels of organization of living things, basis of heredity, and adaptations that explain variations in populations.

- a. Analyze how adaptations to a particular environment (e.g., desert, aquatic, high altitude) can increase an organism's survival and reproduction and relate organisms and their ecological niches to evolutionary change and extinction. (DOK 3)

- b. Compare and contrast the major components and functions of different types of cells. (DOK 2)
  - Differences in plant and animal cells
  - Structures (nucleus, cytoplasm, cell membrane, cell wall, mitochondrion, and nuclear membrane)
  - Different types of cells and tissues (e.g., epithelial, nerve, bone, blood, muscle)
- c. Describe how viruses, bacteria, fungi, and parasites may infect the human body and interfere with normal body functions. (DOK 1)
- d. Describe heredity as the passage of instructions from one generation to another and recognize that hereditary information is contained in genes, located in the chromosomes of each cell. (DOK 2)
  - How traits are passed from parents to offspring through pairs of genes
  - Phenotypes and genotypes
  - Hierarchy of DNA, genes, and chromosomes and their relationship to phenotype
  - Punnett square calculations
- e. Explain energy flow in a specified ecosystem. (DOK 2)
  - Populations, communities, and habitats
  - Niches, ecosystems and biomes
  - Producers, consumers and decomposers in an ecosystem
- f. Develop a logical argument for or against research conducted in selective breeding and genetic engineering, including (but not limited to) research conducted in Mississippi. Examples from Mississippi include the following: (DOK 3)
  - The Animal Functional Genomics Laboratory at Mississippi State University
  - The Stoneville Pedigreed Seed Company in Stoneville, MS
  - Catfish Genetics Research Unit at the Thad Cochran National Warm Water Aquaculture Center in Stoneville, MS
- g. Research and draw conclusions about the use of single-celled organisms in industry, in the production of food, and impacts on life. (DOK 3)
- h. Describe how an organism gets energy from oxidizing its food and releasing some of its energy as heat. (DOK 1)

## EARTH AND SPACE SCIENCE

### 4. Describe the Earth's System in terms of its position to objects in the universe, structure and composition, climate, and renewable and nonrenewable resources.

- a. **Compare and contrast the lithosphere and the asthenosphere. (DOK 1)**
- **Composition, density, and location of continental crust and oceanic crust**
  - **Physical nature of the lithosphere (brittle and rigid) with the asthenosphere (plastic and flowing)**
  - **How the lithosphere responds to tectonic forces (faulting and**

**folding)**

- b. **Describe the cause and effect relationship between the composition of and movement within the Earth's lithosphere. (DOK 1)**
- **Seismic wave velocities of earthquakes and volcanoes to lithospheric plate boundaries using seismic data**
  - **Volcanoes formed at mid-ocean ridges, within intra-plate regions, at island arcs, and along some continental edges**

Modern distribution of continents to the movement of lithospheric plates since the formation of Pangaea

- c. **Examine weather forecasting and describe how meteorologists use atmospheric features and technology to predict the weather. (DOK 2)**
- **Temperature, precipitation, wind (speed/direction), dew point, relative humidity, and barometric pressure**
- **How the thermal energy transferred to the air results in vertical and horizontal movement of air masses, Coriolis effect**

Global wind patterns (e.g., trade winds, westerlies, jet streams) Satellites and computer modeling

- d. **Research the importance of the conservation of renewable and nonrenewable resources, including (but not limited to) Mississippi, and justify methods that might be useful in decreasing the human impact on global warming.**

**(DOK 3) Greenhouse gases**

The effects of the human population

Relationships of the cycles of water, carbon, oxygen, and nitrogen

- e. **Explain how the tilt of Earth's axis and the position of the Earth in relation to the sun determine climatic zones, seasons, and length of the days. (DOK 2)**
- f. **Describe the hierarchical structure (stars, clusters, galaxies, galactic clusters) of the universe and examine the expanding universe to include its age and history and the modern techniques (e.g., radio, infrared, ultraviolet and X-ray astronomy) used to measure objects and distances in the universe. (DOK 2)**

- g. Justify the importance of continued research and use of new technology in the development and commercialization of potentially useful natural products, including, but not limited to research efforts in Mississippi. (DOK 3)
- The Thad Cochran National Center for Natural Products Research, housed at the University of Mississippi
  - The Jamie Whitten Delta States Research Center in Stoneville, MS, The
  - Mississippi Polymer Institute, housed at the University of Southern Mississippi
- h. Justify why an imaginary hurricane might or might not hit a particular area, using important technological resources including (but not limited to) the following: (DOK 2)
- John C. Stennis Space Center Applied Research and Technology Project Office in Hancock County
  - National Oceanic and Atmospheric Administration (NOAA)
  - The National Weather Service

# PHYSICAL SCIENCE

- one credit -

The *Physical Science* course provides opportunities for students to develop and communicate an understanding of physics and chemistry through lab-based activities, mathematical expressions, and concept exploration. Concepts covered in this course include structure of matter, chemical and physical properties and changes, kinematics, dynamics, energy, waves, electromagnetic spectrum, electricity, and magnetism. Laboratory activities, the use of technology, and the effective communication of results through various methods are integral components of this course.

The *Mississippi Science Framework* is comprised of three content strands: **Life Science, Earth and Space Science, and Physical Science**. The five process strands are **Science as Inquiry, Unifying Concepts and Processes, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science**. The three content strands, along with the five process strands, combine to provide continuity to the teaching of K-12 science. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum. **Science as Inquiry** is listed as a separate strand in order to place emphasis on developing the ability to ask questions, to observe, to experiment, to measure, to problem solve, to gather data, and to communicate findings. **Inquiry is not an isolated unit of instruction and must be embedded throughout the content strands.**

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

# PHYSICAL SCIENCE

Algebra I as a pre- or co-requisite  
- one credit -

## CONTENT STRANDS:

Inquiry  
Physical Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
  - Safety symbols and safety rules in all laboratory activities
  - Proper use and care of the compound light microscope
  - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Identify questions that can be answered through scientific investigations. (DOK 3)
- c. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
  - Predicting, gathering data, drawing conclusions
  - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
  - Critically analyzing current investigations/problems using periodicals and scientific scenarios
- d. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs.) (DOK 2)
- e. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

## PHYSICAL SCIENCE

### 2. Describe and explain how forces affect motion.

- a. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
  - Inertia and distance-time graphs to determine average speed
  - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
  - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
  - Simple harmonic motion (oscillation)
- b. Explain the connection between force, work, and energy. (DOK 2) Force
  - exerted over a distance (results in work done)
  - Force-distance graph (to determine work)
  - Net work on an object which contributes to change in kinetic energy (work-to-energy theorem)
- c. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
- d. Draw and assess conclusions about charges and electric current. (DOK 2)
  - Static/current electricity and direct current/alternating current Elements
  - in an electric circuit that are in series or parallel Conductors and
  - insulators
  - Relationship between current flowing through a resistor and voltage flowing across a resistor
- e. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's Law). (DOK 2)

### 3. Demonstrate an understanding of general properties and characteristics of waves.

- a. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
- b. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler Effect) and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)

- c. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength and draw conclusions about their impact on life. (DOK 2)
  - The emission of light by electrons when moving from higher to lower levels
  - Energy (photons as quanta of light)
  - Additive and subtractive properties of colors
  - Relationship of visible light to the color spectrum
- d. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)

#### 4. Develop an understanding of the atom.

- a. Cite evidence to summarize the atomic theory. (DOK 1)
  - Models for atoms
  - Hund's rule and Aufbau process to specify the electron configuration of elements
  - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.) Atomic orbitals (s, p, d, f) and their basic shapes
- b. Explain the difference between chemical and physical changes and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
- c. Research the history of the periodic table of the elements and summarize the contributions which led to the atomic theory. (DOK 2)
  - Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
  - Technology (e.g., x-rays, cathode-ray tubes, spectrosopes)
  - Experiments (e.g., gold-foil, cathode-ray, etc.)
- d. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2) Atomic
  - composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
  - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
  - Average atomic mass from isotopic abundance
  - Solids, liquids, and gases
  - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table

**5. Investigate and apply principles of physical and chemical changes in matter.**

- a. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
- b. Balance chemical equations. (DOK 2)
- c. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

# PHYSICS

- one credit -

*Physics* provides opportunities for students to develop and communicate an understanding of matter and energy through lab-based activities, mathematical expressions, and concept exploration. Concepts covered in this course include kinematics, dynamics, energy, mechanical and electromagnetic waves, and electricity. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# PHYSICS

(Trigonometry as a pre- or co-requisite)  
- one credit -

## CONTENT STRANDS:

Inquiry  
Physical Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs) draw conclusions and make inferences. (DOK 3)
- e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.) (DOK 3)

### PHYSICAL SCIENCE

#### 2. Develop an understanding of concepts related to forces and motion.

- a. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
  - Vector and scalar quantities
  - Vector problems (solved mathematically and graphically)
  - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
  - Relations among mass, inertia, and weight

- b. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of freefall). (DOK 2)
- c. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
- d. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2) Situations
  - where  $g$  is constant (falling bodies)
  - Concept of centripetal acceleration undergoing uniform circular motion
  - Kepler's third law
  - Oscillatory motion and the mechanics of waves

### 3. Develop an understanding of concepts related to work and energy.

- a. Explain and apply the conservation of energy and momentum. (DOK 2)
  - Concept of work and applications
  - Concept of kinetic energy, using the elementary work-energy theorem
  - Concept of conservation of energy with simple examples
  - Concepts of energy, work, and power (qualitatively and quantitatively)
  - Principles of impulse in inelastic and elastic collisions
- b. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
- c. Apply the principles of impulse and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
- d. Investigate and summarize the principles of thermodynamics. (DOK 2) How heat energy is transferred from higher temperature to lower temperature until
  - equilibrium is reached
  - Temperature and thermal energy as related to molecular motion and states of matter
  - Problems involving specific heat and heat capacity
  - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
  - e. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

### 4. Discuss the characteristics and properties of light and sound.

- a. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
  - Simple harmonic motion
  - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
  - Energy of a wave in terms of amplitude and frequency.
  - Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)

- b. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
- c. Explain the laws of reflection and refraction and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
- d. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
- e. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

**5. Apply an understanding of magnetism, electric fields, and electricity.**

- a. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
  - Characteristics of static charge and how a static charge is generated
  - Electric field, electric potential, current, voltage, and resistance as related to Ohm's Law
  - Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
  - Coulomb's Law
- b. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
- c. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

**6. Analyze and explain concepts of nuclear physics.**

- a. Analyze and explain the principles of nuclear physics. (DOK 1)
  - The mass number and atomic number of the nucleus of an isotope of a given chemical element
  - The conservation of mass and the conservation of charge
  - Nuclear decay
- b. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
  - Quantum energy and emission spectra
  - Photoelectric and Compton effects

# CHEMISTRY

- one credit -

*Chemistry* provides opportunities for students to develop and communicate an understanding of structure, physical and chemical properties, and chemical change. Concepts covered in this course include properties of matter, measurement and use of the International System of Measurement applied to mathematical operations, atomic theory, bonding, periodicity, nomenclature, equations and reactions, stoichiometry of aqueous solutions, thermodynamics, kinetics, equilibrium, oxidation-reduction and electron chemistry, nuclear chemistry, and organic chemistry. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# CHEMISTRY

(Algebra II as pre- or co-requisite)

- one credit -

## CONTENT STRANDS:

Inquiry  
Physical Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.) (DOK 3)

### PHYSICAL SCIENCE

#### 2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

- a. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
  - Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
  - Substances and mixtures
  - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them

- b. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
- c. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
- Properties and interactions of the three fundamental particles of the atom Laws of
- conservation of mass, constant composition, definite proportions, and
  - multiple proportions
- d. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of
- the emissions (e.g., composition, mass, charge, penetrating power)
  - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process
- e. Compare the properties of compounds according to their type of bonding. (DOK 1)
- Covalent, ionic, and metallic bonding
- Polar and non-polar covalent bonding
  - Valence electrons and bonding atoms
  - f. Compare different types of intermolecular forces and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)
- g. Develop a three-dimensional model of molecular structure. (DOK 2) Lewis dot structures for simple molecules and ionic compounds Valence shell electron pair repulsion theory (VSEPR)
- - **3. Develop an understanding of the periodic table.**
- a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- b. Analyze patterns and trends in the organization of elements in the periodic table and compare their relationship to position in the periodic table. (DOK 2) Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
  - Chemical characteristics of each region
  - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy,
  - atomic/covalent/ionic radius)

- c. Classify chemical reactions by type. (DOK 2)
  - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation.
  - Products (given reactants) or reactants (given products) for each reaction type
  - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
  - Difference between chemical reactions and chemical equations
  - Formulas and calculations of the molecular (molar) masses
  - Empirical formula given the percent composition of elements
  - Molecular formula given the empirical formula and molar mass

**4. Analyze the relationship between microscopic and macroscopic models of matter.**

- a. Analyze the nature and behavior of gaseous, liquid, and solid substances using the kinetic molecular theory. (DOK 3)
- b. Use the ideal gas laws to explain the relationships between volume, temperature, pressure, and quantity in moles. (DOK 2)
  - Difference between ideal and real gas
  - Assumptions made about an ideal gas
  - Conditions that favor an ideal gas
- c. Use the gas laws of Boyles, Charles, Gay-Lussac, and Dalton to solve problems based on the laws. (DOK 2)
- d. Explain the thermodynamics associated with physical and chemical concepts related to temperature, entropy, enthalpy, and heat energy. (DOK 2)
  - Specific heat as it relates to the conservation of energy
  - Amount of heat absorbed or released in a process, given mass, specific heat, and temperature change
  - Energy (in calories and joules) required to change the state of a sample of a given substance, using its mass and its heat of vaporization or heat of fusion.
  - Endothermic or exothermic changes
- e. Describe and identify factors affecting the solution process, rates of reaction, and equilibrium. (DOK 2)
  - Concentration of a solution in terms of its molarity, using stoichiometry to perform specified dilutions
  - Chemical reaction rates affected by temperature, concentration, surface area, pressure, mixing, and the presence of a catalyst
  - Relationship of solute character
  - LeChatelier's Principle

**5. Compare factors associated with acid/base and oxidation/reduction reactions.**

- a. Analyze and explain acid/base reactions. (DOK 2)
  - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
  - Formation of acidic and basic solutions
  - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
  - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
  - How a buffer works and examples of buffer solutions
- b. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions, respectively and predict products for aqueous neutralization reactions. (DOK 2)
- c. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

# ORGANIC CHEMISTRY

- one half credit -

The *Organic Chemistry* course provides opportunities for students to develop and communicate an understanding of the structure, nomenclature, reactions and uses of organic compounds, including polymeric materials. Laboratory experiences should allow the student to manipulate compounds, observe change, collect and analyze data, and draw conclusions. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# ORGANIC CHEMISTRY

- one half credit -

## CONTENT STRANDS:

Inquiry  
Physical Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
  - Safety rules and symbols
  - Proper use and care of the compound light microscope, slides, chemicals, etc.
  - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

## PHYSICAL SCIENCE

### 2. Demonstrate an understanding of the properties, structure and function of organic compounds.

- a. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
  - Structures of hydrocarbon compounds
  - Isomerism in hydrocarbon compounds
- b. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
- c. Apply principles of geometry and hybridization to organic molecules. (DOK 2) Lewis
  - structures for organic molecules Bond angles
  - Hybridization (as it applies to organic molecules)
  - d. Write, complete and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
- e. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
- f. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties. (DOK 2)

Structural formulas from functional group names and vice-versa

- Chemical and physical properties of compounds containing functional groups
- Equations representing the transformation of one functional group into another
- 

### 3. Discuss the versatility of polymers and the diverse application of organic chemicals.

- a. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)

Common polymers

- Synthesis of polymers from monomers by addition or condensation
- Condensations of plastics according to their commercial types
- Elasticity and other polymer properties
- 
-

- b. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
  - Compounds which have the property to dye materials
  - Petrochemical production
  - Biologically active compounds in terms of functional group substrate interaction
- c. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.) (DOK 3)

# INTRODUCTION TO BIOLOGY

- one credit -

This course is **not** a required prerequisite for Biology I; however, if selected as a science elective, *Introduction to Biology* should not be taken after successful completion of Biology I. Concepts covered in this course include scientific problem solving, research, experimental design, laboratory safety, measurement, graphing, characteristics of life, cell structure and function, energy transfer in biological systems, genetics, and diversity of life. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

The *Mississippi Science Framework* is comprised of three content strands: **Life Science, Earth and Space Science, and Physical Science**. The five process strands are **Science as Inquiry, Unifying Concepts and Processes, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science**. The three content strands, along with the five process strands, combine to provide continuity to the teaching of K-12 science. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum. **Science as Inquiry** is listed as a separate strand in order to place emphasis on developing the ability to ask questions, to observe, to experiment, to measure, to problem solve, to gather data, and to communicate findings. **Inquiry is not an isolated unit of instruction and must be embedded throughout the content strands.**

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

The Elementary/Middle School Science Test and Biology I Subject Area Test will be developed based on the objectives found in the framework. At least fifty percent (50%) of the test items on the Elementary/Middle School Science Test must match the Depth of Knowledge (DOK) level assigned to the objectives for each competency. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

# INTRODUCTION TO BIOLOGY

- one credit -

## CONTENT STRANDS:

**Inquiry  
Life Science**

**Physical Science**

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
  - Safety rules and symbols
  - Proper use and care of the compound light microscope, slides, chemicals, etc.
  - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Identify questions that can be answered through scientific investigations. (DOK 3)
- c. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
  - Predicting, gathering data, drawing conclusions
  - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
  - Critically analyzing current investigations/problems using periodicals and scientific scenarios
- d. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs. (DOK 2)
- e. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

## PHYSICAL SCIENCE

### 2. Investigate and summarize the chemical basis of life.

- a. Compare and contrast atoms, ions, elements, molecules, and compounds in terms of the relationship of the bond types (e.g., ionic, covalent, and hydrogen bonds) to chemical activity and explain how this is relevant to biological activity. (DOK 2)
- b. Classify pH solutions (e.g., acids, bases, neutrals) and explain the importance of pH in living systems. (DOK 2)
- c. Compare the composition and primary properties of carbohydrates, proteins, lipids, and nucleic acids and relate these to their functions in living organisms. (DOK 2)
- d. Compare and contrast the basic processes of photosynthesis and cellular respiration. (DOK 2)

## LIFE SCIENCE

### 3. Investigate and explain how organisms interact with their environment.

- a. Describe the criteria that must be present to distinguish between living and nonliving. (DOK 1)
  - Homeostasis, adaptation, and response to stimuli
  - Growth, development, reproduction, energy use
  - Levels of organization
- b. Analyze and explain the interactions among organisms for each level of biological organization. (DOK 2)
  - Biotic and abiotic
  - Predation, competition, symbiosis, mutualism, commensalism, parasitism, etc.
  - Food chains, food webs, and food pyramids
- c. Analyze energy flow through an ecosystem by assessing the roles of carnivores, omnivores, herbivores, producers, and decomposers and determine their effects on an ecosystem. (DOK 2)
- d. Predict the impact of human activities (e.g., recycling, pollution, overpopulation) on the environment. (DOK 3)

### 4. Investigate, compare, and contrast cell structures, functions, and methods of reproduction.

- a. Compare and contrast cell structures, functions, and methods of reproduction to analyze the similarities and differences among cell types. (DOK 2)
  - Prokaryotic/eukaryotic
  - Unicellular/multicellular
  - Plant/animal/bacterial/protist/fungal

- b. Describe and explain the relationships between structures and functions of major eukaryotic organelles (e.g., cell wall, cell membrane, chromosomes, mitochondrion, nucleus, chloroplast, vacuole, endoplasmic reticulum, ribosomes, centrioles, cytoplasm/cytosol, Golgi apparatus, vesicles, lysosomes, microtubules, microfilaments, cytoskeleton, nucleolus, nuclear membrane.) (DOK 2)
- c. Describe how active, passive, and facilitated transports relate to the maintenance of homeostasis. (DOK 1)
- d. Compare and contrast the processes and results of mitosis and meiosis. (DOK 2)

**5. Analyze the roles DNA and RNA play on the mechanism of inheritance.**

- a. Utilize genetic terminology and principles to solve monohybrid crosses involving dominant and recessive traits. (DOK 2)
- b. Identify inheritance patterns using pedigrees and karyotypes. (DOK 2)
- c. Explain and distinguish among the roles of DNA and RNA in replication, transcription, and translation. (DOK 1)

**6. Apply the concept of evolution to the diversity of organisms.**

- a. Classify organisms into groups based on their unique characteristics (e.g., cell type, nutrition, reproductive methods, organism examples, etc.) and trace the evolutionary relationships among the groups. (DOK 2)
- b. Describe how natural selection relates to adaptation, survival, and speciation. (DOK 1)

# BIOLOGY I

- one credit -

*Biology I* is a laboratory-based course designed to study living organisms and their physical environments. Students should apply scientific methods of inquiry and research in the examination of the chemical basis of life, cell structure, function and reproduction, energy, natural selection and diversity, and ecology. Laboratory activities, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# BIOLOGY I

- one credit -

## CONTENT STRANDS:

**Inquiry  
Life Science**

**Physical Science**

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
  - Safety rules and symbols
  - Proper use and care of the compound light microscope, slides, chemicals, etc.
  - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

### PHYSICAL SCIENCE

#### 2. Describe the biochemical basis of life and explain how energy flows within and between the living systems.

- a. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2) Subatomic particles
  - and arrangement in atoms

- Importance of ions in biological processes
- b. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
- c. Classify solutions as acidic, basic, or neutral and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
- d. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2) Basic
  - chemical composition of each group
  - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
  - Basic functions (e.g., energy, storage, cellular, heredity) of each group
- e. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
  - Enzyme structure
  - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
- f. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
  - ATP structure
  - ATP function
- g. Analyze and explain the biochemical process of photosynthesis and cellular respiration and draw conclusions about the roles of the reactants and products in each. (DOK 3)
  - Photosynthesis and respiration (reactants and products)
    - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
    - Aerobic and anaerobic processes in cellular respiration, including products of each and energy differences

## LIFE SCIENCE

### 3. Investigate and evaluate the interaction between living organisms and their environment.

- a. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
  - Plant and animal species
  - Climate (temperature and rainfall)
  - Adaptations of organisms
  - b. Provide examples to justify the interdependence among environmental elements. (DOK 2)

- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
  - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
  - Roles of beneficial bacteria
  - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)
- c. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)

#### **4. Analyze and explain the structures and function of the levels of biological organization.**

- a. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol) Components of
  - mobility (e.g., cilia, flagella, pseudopodia)
- b. Differentiate between types of cellular reproduction. (DOK 1) Main
- events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions
  - Binary fission (e.g., budding, vegetative propagation, etc.)
  - Significance of meiosis in sexual reproduction
  - Significance of crossing over
- c. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
- d. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)

#### **5. Demonstrate an understanding of the molecular basis of heredity.**

- a. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
  - Processes of replication, transcription, and translation
  - Messenger RNA codon charts
- b. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes.) (DOK 2)

- c. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
- d. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
  - Significance of nondisjunction, deletion, substitutions, translocation, and frame shift mutation in animals
  - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Downs Syndrome, color blindness

**6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.**

- a. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
  - Characteristics of the six kingdoms
  - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
  - Body plans (symmetry)
  - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
  - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
- b. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
- c. Research and summarize the contributions of scientists, (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
- d. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
- e. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

## BIOLOGY II

- one credit -

*Biology II* is a laboratory-based course that continues the study of life. The units studied include biochemical life processes, molecular basis of heredity, natural selection, behavior patterns, and advanced classification and organism studies. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# BIOLOGY II

- one credit -

## CONTENT STRANDS:

Inquiry  
Life Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.) (DOK 3)

### LIFE SCIENCE

#### 2. Describe and contrast the structures, functions, and chemical processes of the cell.

- a. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
- b. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
- c. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
  - The impact of enzymatic reactions on biochemical processes
  - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)

- d. Differentiate between photosynthesis and cellular respiration. (DOK 2) Cellular
- sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
  - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
  - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
  - Oxidation and reduction reactions

### 3. Investigate and discuss the molecular basis of heredity.

- a. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
- b. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
- c. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
- Translation of a messenger RNA strand into a protein
  - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell
  - Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
  - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
- d. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine and forensics
- e. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)

### 4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.

- a. Explain the history of life on Earth and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of Earth's history
  - Roles of catastrophic and gradualistic processes in shaping planet Earth

- b. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
- c. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
- d. Formulate a scientific explanation based on fossil records of ancient life-forms and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
- e. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.) (DOK 2)
- f. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.) (DOK 1)
- g. Research and explain the contributions of 19<sup>th</sup> century scientists (e.g., Malthus, Wallace, Lyell, Darwin) on the formulation of ideas about evolution. (DOK 2)
- h. Develop a logical argument describing ways in which the influences of 20<sup>th</sup> century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
- i. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of non-native species. (DOK 2)

#### **5. Develop an understanding of organism classification.**

- a. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
- b. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)
  - Bacteria, fungi, and protists
  - Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
  - Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
  - Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants).

# GENETICS

- one half credit -

*Genetics* is a laboratory-based course that will explore the principles of classical and molecular genetics including the relationship between traits and patterns of inheritance within organisms. Population genetics, genetic variations among individuals, and applications of modern advances in genetics will be investigated. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# GENETICS

- one half credit -

## CONTENT STRANDS:

Inquiry  
Life Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.) (DOK 3)

### LIFE SCIENCE

#### 2. Analyze the structure and function of the cell and cellular organelles.

- a. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
- b. Describe how organic components are integral to biochemical processes. (DOK 2)
- c. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
  - Cell cycle and mitosis
  - Meiosis, spermatogenesis, and oogenesis

- d. Explain the significance of the discovery of nucleic acids. (DOK 1)
- e. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
- f. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
- g. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

**3. Apply the principles of heredity to demonstrate genetic understandings.**

- a. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
- b. Apply classical genetics principles to solve basic genetic problems. (DOK 2)
  - Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
  - Inheritance of autosomal and sex-linked traits
  - Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
  - Chromosomal theory of inheritance
- c. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
  - Genetic variability
  - Hardy-Weinberg formula
  - Migration and genetic drift
  - Natural selection in humans
- d. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
  - Steps in genetic engineering experiments
  - Use of restriction enzymes
  - Role of vectors in genetic research
  - Use of transformation techniques
- e. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, pedigrees). (DOK 2)
- f. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
- g. Research genomics (human and other organisms.) and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

# MICROBIOLOGY

- one half credit -

*Microbiology* is a laboratory-based course that involves investigating microorganisms and the various roles they play in the living world. Topics explored in this class include identifying common microbes, culturing and staining microorganisms, exploring host-microbe relationships and disease processes, and researching microbiology used in industry. Laboratory work involving microscopic investigations and aseptic techniques are emphasized in this course as well as critical thinking, problem solving, and research.

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# MICROBIOLOGY

- one half credit -

## CONTENT STRANDS:

**Inquiry  
Life Science**

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.) (DOK 3)

### LIFE SCIENCE

#### 2. Develop understandings about the importance of historical microbiology to today's society.

- a. Analyze and draw conclusions about of the work of Robert Koch. (DOK 2)
  - Discovery that microorganisms cause disease
  - Importance of Koch's postulates
- b. Research the societal and economic contributions of scientists (e.g., Louis Pasteur, John Snow, Edward Jenner, Joseph Lister, Alexander Fleming, etc.) and explain their impact on microbiology. (DOK 2)

- c. Research and evaluate the relevance of various careers in modern microbiology. (DOK 2)

**3. Explore and demonstrate an understanding of the classification of microorganisms.**

- a. Cite examples to differentiate between the characteristics of eukaryotes and prokaryotes. (DOK 1)
- b. Cite examples and compare the characteristics of prokaryotes, fungi, and protists. (DOK 2)

**4. Investigate and summarize concepts related to pathogenic microbiology.**

- a. Research and interpret with examples the causes and effects of epidemics and pandemics. (DOK 2)
- b. Justify an explanation of strategies that can be used to reduce a person's chance of becoming infected with a pathogen. (DOK 3)
  - Vaccination as it relates to immunity
  - Hospital procedures for dealing with infectious diseases

**5. Examine and evaluate the classification, morphology, characteristics, pathology, and benefits associated with bacteria.**

- a. Differentiate between eubacteria and archaeobacteria (DOK 1)
- b. Analyze and distinguish the characteristics of bacteria. (DOK 2)
  - Shapes, motility structures, formation of endospores and capsules
  - Structure and function of internal and external bacterial cell components
  - Principles of Gram staining
- c. Research and explain the characteristics, causes, and treatments of bacterial diseases. (DOK 2)
- d. Explain and describe the factors leading to antibiotic resistance among bacteria and predict its potential impacts on society. (DOK 2)
- e. Research and evaluate the beneficial aspects of bacteria in medicine, industry, and daily life. (DOK 3)

**6. Differentiate among the growth requirements of bacteria.**

- a. Describe growth requirements of bacteria. (DOK 2)
  - Effectiveness of household antiseptics and disinfectants in controlling bacterial growth
  - Effect of pH and temperature on bacterial growth
- b. Compare and contrast aerobes and anaerobes, both facultative and obligative, and predict their impact on human life. (DOK 2)
- c. Compare and interpret the results of investigations with various growth mediums. (DOK 3)

**7. Develop an understanding of classification, morphology, characteristics, pathology and benefits associated with viruses.**

- a. Research and explain the characteristics, causes, and treatments of viral diseases, (e.g., smallpox, polio, influenza, measles, rabies, tumor viruses, common cold, hepatitis, herpes simplex I and II, chickenpox, shingles, HIV, warts, genital warts, etc.) (DOK 3)
  - Structure of viruses, including a phage virus
  - Methods to culture viruses in a laboratory
  - Life cycle of a virus
- b. Cite evidence and explanations to defend the societal and economic importance of viruses. (DOK 2)

**8. Develop an understanding of the classification, morphology, characteristics, pathology, and benefits associated with fungi.**

- a. Summarize the characteristics, causes, and treatment of the most common types of fungal diseases. (DOK 2)
  - Structure of fungal cells
  - Growth requirements and reproduction of fungi
  - Methods to culture fungi in a laboratory
- b. Cite evidence and explanations to support the societal and economic significance of fungi. (DOK 2)

**9. Demonstrate an understanding of microorganisms as they relate to food processes.**

- a. Analyze and evaluate microbial actions in major industrial processes involving foods. (DOK 3)
  - Process of pasteurization of milk and its effect on microorganisms
  - Process of fermentation in producing certain foods.
  - Microbial problems in the slaughter of animals and preservation of fresh meat
  - Importance of bacteria in the process of making certain foods
  - E.coli.related outbreaks in meats and produce
- b. Compare and contrast methods of food preservation. (DOK 2)
  - Home canning and industrial canning
  - Dehydration
  - Meals, Ready-to-Eat technology (MRE)
- c. Describe the causes and effects of food poisoning and discuss preventive strategies. (DOK 2)

# BOTANY

- one half credit -

*Botany* is a laboratory-based course applying basic biological principles to the study of plants. Topics studied include morphological characteristics of each division and variation in their reproduction, taxonomy, and physiology. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# **BOTANY**

- one half credit -

## **CONTENT STRANDS:**

**Inquiry  
Life Science**

## **COMPETENCIES AND OBJECTIVES:**

### **INQUIRY**

#### **1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.**

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
  - Safety rules and symbols
  - Proper use and care of the compound light microscope, slides, chemicals, etc.
  - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

### **LIFE SCIENCE**

#### **2. Distinguish among the characteristics of botanical organization, structure, and function.**

- a. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)

- b. Differentiate the characteristics found in various plant divisions. (DOK 2)
  - Differences and similarities of nonvascular plants
  - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
  - Major vegetative structures and their modifications in angiosperms and gymnosperms
- c. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
- d. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
  - Classification scheme used in botany
  - Classification of native Mississippi plants
- e. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
  - Relationships among photosynthesis, cellular respiration, and translocation
  - Importance of soil type and soil profiles to plant survival
  - Mechanism of water movement in plants
  - Effects of environmental conditions for plant survival
  - Tropic responses of a plant organ to a given stimulus

### **3. Demonstrate an understanding of plant reproduction.**

- a. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
- b. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
- c. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
  - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
  - Functions of flower parts, seeds, cones
  - Spore production in bryophytes and ferns
- d. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
- e. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
- f. Research and compare various methods of plant propagation. (DOK 2)

### **4. Draw conclusions about the factors that affect the adaptation and survival of plants.**

- a. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
- b. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

- c. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
- d. Research factors that might influence or alter plant stability and propose actions that may reduce the negative impacts of human activity. (DOK 2)

**5. Relate an understanding of plant genetics to its uses in modern living.**

- a. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology (DOK 3)
- b. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
- c. Discuss the effects of genetic engineering of plants on society. (DOK 2)
- d. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)

Plant extracts, their function, and origin

- Impact of the timber industry on local and national economy
-

# ZOOLOGY

- one half credit -

*Zoology* is a laboratory-based course that surveys the nine major phyla of the Kingdom Animalia. Morphology, taxonomy, anatomy, and physiology should be investigated. Comparative studies may be addressed during laboratory observations and dissections. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# ZOOLOGY

- one half credit -

## CONTENT STRANDS:

**Inquiry**  
**Life Science**

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
  - Safety rules and symbols
  - Proper use and care of the compound light microscope, slides, chemicals, etc.
  - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

### LIFE SCIENCE

#### 2. Develop an understanding of levels of organization and animal classification.

- a. Explain how organisms are classified and identify characteristics of major groups. (DOK 1)
  - Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
  - Characteristics used to classify organisms (e.g., cell

structure, biochemistry, anatomy, fossil record, and methods of reproduction)

- b. Identify and describe characteristics of the major phyla. (DOK 1)
  - Symmetry and body plan
  - Germ layers and embryonic development
  - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
  - Locomotion and coordination
- c. Distinguish Viruses from Bacteria and Protists and give examples. (DOK 1)
- d. Differentiate among the characteristics of Bacteria, Archaea, and Eucarya. (DOK 1)
  - Phylogenetic sequencing of the major phyla
  - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, Arthropoda (Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
  - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

### **3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.**

- a. Describe life cycles, alternation of generations, and metamorphosis of various animals and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
- b. Describe and explain concepts of animal behavior and differentiate between learned and innate behavior. (DOK 1)
  - Division of labor within a group of animals
  - Communication within animals groups
  - Degree of parental care given in animal groups
- c. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
- d. Compare and contrast ecological relationships and make predictions about the survival of populations under given circumstances. (DOK 3)
  - Terrestrial and aquatic ecosystems
  - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
  - Symbiotic relationships such as mutualism, commensalisms, and parasitism
- e. Contrast food chains and food webs. (DOK 2)

**4. Demonstrate an understanding of the principles of animal genetic diversity and evolution.**

- a. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, non-disjunction) and the population level (e.g., non-random mating, migration, etc.) (DOK 2)
  - Relationship between natural selection and evolution
  - Mutations, crossing over, non-disjunction
  - Non-random mating, migration, etc.
  - Effects of genetic drift on evolution
- b. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

# MARINE AND AQUATIC SCIENCE

- one half credit -

*Marine and Aquatic Science* is a laboratory-based and field-based course that investigates the biodiversity of salt water and fresh water organisms, including their interactions with the physical and chemical environment. The special characteristics of aquatic resources should also be examined. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# MARINE & AQUATIC SCIENCE

- one half credit -

## CONTENT STRANDS:

Inquiry  
Life Science  
Earth and Space Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
  - Safety rules and symbols
  - Proper use and care of the compound light microscope, slides, chemicals, etc.
  - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

### EARTH AND SPACE SCIENCE

#### 2. Develop an understanding of physical and chemical properties of water and aquatic environments.

- a. Analyze the physical and chemical properties of water and justify why it is essential to living organisms. (DOK 1)

- b. Explain the causes and characteristics of tides. (DOK 1)
- c. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)
- d. Compare and contrast the physical and chemical parameters of dissolved O<sub>2</sub>, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
- e. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
- f. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
  - Plate tectonics
  - Rise, slope, elevation, and depth
  - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
  - Watershed formation as it relates to bodies of fresh water
- g. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
  - Barrier island, coral reef, tidal pool, and ocean
  - River, stream, lake, pond, and swamp
  - Bay, sound, estuary, and marsh

## **LIFE SCIENCE**

### **3. Apply an understanding of the diverse organisms found in aquatic environments.**

- a. **Analyze and explain the diversity and interactions among aquatic life.**
  - **(DOK 3) Adaptations of representative organisms for their aquatic environments**
  - **Relationship of organisms in food chains/webs within aquatic environments.**
- b. **Research, calculate, and interpret population data. (DOK 2)**
- c. **Research and compare reproductive processes in aquatic organisms. (DOK 2)**
- d. **Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)**
- e. **Explore the taxonomy of aquatic organisms and use dichotomous keys to differentiate among the organisms. (DOK 2)**
- f. **Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)**

**4. Draw conclusions about the relationships between human activity and aquatic organisms.**

- a. Describe the impact of natural and human activity on aquatic ecosystems and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
  - Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
  - Effectiveness of a variety of methods of environmental management and stewardship
  - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
- b. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
- c. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
  - Careers related to aquatic science
  - Modern technology within aquatic science (e.g., mariculture, aquaculture)
  - Contributions of aquatic technology to industry and government

# HUMAN ANATOMY AND PHYSIOLOGY

- one credit -

*Human Anatomy and Physiology* is a laboratory-based course that investigates the structure and function of the human body. Topics covered include the basic organization of the body, biochemical composition, and major body systems along with the impact of diseases on certain systems. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# HUMAN ANATOMY & PHYSIOLOGY

- one credit -

## CONTENT STRANDS:

**Inquiry  
Life Science**

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.) (DOK 3)

### LIFE SCIENCE

#### 2. Demonstrate an understanding of the basic organization of the body.

- a. Apply and relate appropriate anatomical terms to the body in anatomical position. (DOK 1)
  - Relationship of body parts
  - Major cavities and essential organs
- b. Explain how specific mechanisms (e.g., feedback, transport, pH, temperature regulation, etc.) maintain homeostasis. (DOK 1)
- c. Describe the relationships and interactions of biochemical composition of the human body to body functions. (DOK 2)
  - Compounds and elements necessary for maintaining life

- Major groups of organic substances in the human body
- Major types of chemical reactions employed within the organ systems
- Effects of external factors (e.g., heat, pH, etc.) on enzymatic reactions
- d. Categorize the relationship of the cell and its functions to the more complex levels of organization within the body. (DOK 2)

Anabolic and catabolic reactions within a human cell

- Four major categories of tissues and their location, structure, and function

### **3. Demonstrate an understanding of the structure, functions, and relationships of the body systems.**

- a. Identify structures and explain functions of the components of the integumentary system. (DOK 1)
- b. Research and distinguish among common integumentary system disorders in terms of origin, manifestation, and treatments. (DOK 1)
- c. Compare the structure and functions of the skeletal system with its relationship to movement. (DOK 1)
  - Structures which comprise bone
    - Difference between endochondrial and intramembranous ossification
  - Major bones of the axial and appendicular skeleton, noting inherent differences between males and females
  - Types of joints and their movements
  - d. Research and draw conclusions about changes in the skeletal system associated with disease, disorder, injury, age, and stress. (DOK 3)
- e. Compare the functions and structures of the muscular system with its relationship to movement. (DOK 1)
  - Major components and functions of skeletal muscle fiber
  - Major skeletal muscles and the process of contraction
  - Three types of muscles in the body
- f. Research and evaluate the impact of medical technology on muscle physiology and disease. (DOK 3)
- g. Relate the components of the nervous system to the senses and the functions of the human body systems. (DOK 1)
  - Four types of neurological cells and the functions of each
  - Conduction of a nerve impulse
  - Structures and functions of the brain and spinal cord
  - Divisions of the nervous system (e.g., central nervous system, peripheral nervous system, sympathetic and parasympathetic, etc.)
- h. Describe functions of the various sense organs and identify environmental factors that affect their responses. (DOK 1)
- i. Distinguish the location, structure, and functions of the endocrine glands. (DOK 1)

- Major endocrine glands
  - Function of each endocrine gland and the various hormones they generated by each
  - Negative feedback mechanisms that regulate hormonal secretions.
- j. Research common disorders or diseases of the endocrine system and assess the unique problems associated with diagnoses and treatments. (DOK 3)
- k. Identify and discuss the structures and functions of the organs of the digestive system and discuss their relationships to the interaction among the human body systems. (DOK 2)
- Major organs of the digestive system (e.g., alimentary canal and accessory structures)
  - Roles of organs in the mechanical and chemical digestion of food and nutrient absorption
  - Contents of the alimentary canal and how they are mixed and moved
  - Enzymes and gland secretions as related to the absorption of digestion products
- l. Research common disorders or diseases of the digestive system and identify a diagnosis, based upon a given set of symptoms, for a specific disorder. (DOK 3)
- m. Describe the primary functions of the respiratory organs and the relationships between structure and function. (DOK 1)
- Breathing versus respiration
  - Gaseous exchange between air and blood and mechanisms of gaseous transport by the blood
- n. Research to describe various diseases commonly affecting normal respiratory function and assert environmental and social factors which may contribute to the incidence of disease. (DOK 2)
- o. Demonstrate an understanding of the structures and functions of the circulatory system and their role in maintaining homeostasis. (DOK 2)
- Blood types and the four parts of blood in terms of morphology, function and origin
  - Pulmonary and systemic circulation
  - Systolic and diastolic pressures in relationship to cardiovascular health
- p. Investigate and describe the social and economic impact of technological advances in medical treatment on cardiovascular disorders. (DOK 3)
- q. Describe and discuss the structures and functions of the lymphatic system and the relationships to the circulatory system and immunity. (DOK 1) Major
- lymphatic organs and pathways
  - Functions of lymph nodes, lymphocytes, immunoglobulins, thymus, and spleen
  - Types of immunity and immune responses
- r. Research and describe common lymphatic disorders and present conclusions about the effectiveness of available treatment options. (DOK 3)
- s. Explain the role of the structures and functions of the urinary system as they relate to the formation, composition and elimination of urine. (DOK 1)

- t. Research and describe the treatments of common urinary system disorders.  
(DOK 1)
- u. Identify and discuss the locations, structures, and functions of the major components of the male and female reproductive systems. (DOK 1) Role of
  - hormones in maturation and reproduction
  - Development of a fetus.
- v. Research common reproductive diseases and disorders and justify the need for continued research in the diagnosis and treatment of reproductive system diseases.  
(DOK 3)

# BIOMEDICAL RESEARCH

- one credit -

*Biomedical Research* is an inquiry-based, technology-oriented, and laboratory-intensive elective course that prepares students to participate in professional biomedical research activities at the university level. Major areas of study include electronic access to international biomedical literature data bases, use of the Internet to communicate with biomedical researchers and other students at remote sites, contemporary ethical considerations in the conduct and publication of research, fundamentals of molecular biology and genetics, classification and nomenclature for organic chemical reactions, and elements of cellular and human physiology. Laboratory exercises concentrate upon the fundamental principles of chromatographic separation, the theory and use of a spectrophotometer, quantitative analysis of protein concentration, preparation of DNA, and quantitative preparation of organic compounds.

The *Mississippi Science Framework* is comprised of three content strands: **Life Science, Earth and Space Science, and Physical Science**. The five process strands are **Science as Inquiry, Unifying Concepts and Processes, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science**. The three content strands, along with the five process strands, combine to provide continuity to the teaching of K-12 science. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum. **Science as Inquiry** is listed as a separate strand in order to place emphasis on developing the ability to ask questions, to observe, to experiment, to measure, to problem solve, to gather data, and to communicate findings. **Inquiry is not an isolated unit of instruction and must be embedded throughout the content strands.**

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

# BIOMEDICAL RESEARCH

- one credit -

## CONTENT STRANDS:

Inquiry  
Life Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.) (DOK 3)

### LIFE SCIENCE

#### 2. Demonstrate an understanding of the processes and resources used in biomedical research.

- a. Explore the processes and technologies by which biomedical scientific literature is stored, catalogued, and retrieved and communicate technical approaches and conclusions pertaining to contemporary professional biomedical research publications. (DOK 2)
  - Student-created glossary of technical scientific terminology from the selected readings
  - Biomedicine-related websites, including the Center for Disease

Control, the National Institute of Health, the Howard Hughes Medical Institute, and the Society for Neuroscience

- Additional resources (e.g., textbooks, periodicals, personal interviews with a scientist or teacher familiar with that area of research) needed to assess research findings
- b. Identify the research area of a particular biomedical researcher and summarize a research article upon which to draw conclusions about the importance of the researcher's work. (DOK 2)
- c. Critique a current research article from a specified internet site. (DOK 3)
- d. Communicate with science students at other high school sites using electronic communications to compare and contrast conclusions about specified research topics. (DOK 3)

**3. Analyze contemporary issues, related to the practice or application of biomedical research, that pose a dilemma or dilemmas for our society.**

- a. Identify, research, and summarize current, topical advances in biomedical research and healthcare areas. (Suggested areas of initial focus including fetal tissue research, legalization of drugs, drug abuse, euthanasia, research fraud, use of non-human animals in research, genetic engineering, and universal health care. DOK 4)
  - Biomedical science areas of personal interest
  - Key areas of human physiology towards which a major commitment of United States federal funding of biomedical research is applied
- b. Research, develop, and present a justifiable argument for or against a biomedical issue. (DOK 3)

**4. Investigate and describe the basic elements of genetics and molecular biology that are fundamental to modern biomedical research.**

- a. Research and describe major historical events leading to the development of the science of genetics. (DOK 3)
  - Events that have revolutionized genetic analysis and manipulation, including the polymerase chain reaction (PCR), gene transfection, the Human Genome Project, protein sequencing, and *in vitro* fertilization
  - Influence that environmental pollutants and other man-made chemicals could have on the regulation of protein synthesis and reproduction
  - Subcellular organelles responsible for protein synthesis and reproduction
    - b. Apply formulas and properties in analyzing hydrocarbon families. (DOK 1) Bonding families of hydrocarbons
  - Structural formulas for substituted and non-substituted hydrocarbons

- c. Interpret the basis for optical resolution between stereoisomers and the use of nuclear magnetic resonance, MRI, CAT, PET, etc., for structural determinations. (DOK 2)
- d. Describe the use of protein crystallography in the determination of the structure of deoxyribonucleic acid (DNA). (DOK 2)

**5. Demonstrate proficiency in the application of fundamental technical procedures related to biomedical laboratory research activities.**

- a. Demonstrate an understanding of the skills necessary to set up, operate, and interpret the results from the use of the laboratory spectrophotometer. (DOK 2)
- b. Utilize the process of paper chromatography to identify the components of a chemical mixture. (DOK 2)
- c. Use the Lowry method to distinguish among chemical reactions essential to the calculation of protein concentrations in a solution. (DOK 1)
- d. Describe and demonstrate the use of accurate and safe pipetting techniques in the preparation of a series of protein dilutions. (DOK 1)
- e. Explain the process used to sample organic compounds, including methane, ethane, acetic acid, ethyl ethanoate, and methanol. (DOK 1)

# EARTH AND SPACE SCIENCE

- one credit -

*Earth and Space Science* is an introductory, laboratory-based course designed to explore the Earth and Universe. Topics include the composition of the Earth, weathering, plate tectonics, fossils, oceanography, atmospheric phenomena, the water cycle, and planetary and star systems. Laboratory activities, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# EARTH AND SPACE SCIENCE

- one credit -

## CONTENT STRANDS:

Inquiry  
Earth and Space Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
  - Safety rules and symbols
  - Proper use and care of the compound light microscope, slides, chemicals, etc.
  - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

### EARTH AND SPACE SCIENCE

#### 2. Develop an understanding of the history and evolution of the universe and Earth.

- a. Summarize the origin and evolution of the universe. (DOK 2)
  - Big Bang theory
  - Microwave background radiation
  - The Hubble constant

- Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
- b. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
- c. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)
- d. Summarize the early evolution of the Earth, including the formation of Earth’s solid layers (e.g., core, mantle, crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2) How the decay of radioactive isotopes is used to determine the age of rocks, Earth, and the solar system
  - How Earth acquired its initial oceans and atmosphere

**3. Discuss factors which are used to explain the geological history of Earth.**

- a. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
  - Plate tectonic boundaries (e.g., divergent, convergent, and transform)
  - Modern and ancient geological features to each kind of plate tectonic boundary
  - Production of particular groups of igneous and metamorphic rocks and mineral resources
  - Sedimentary basins created and destroyed through time
  - b. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
- c. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
- d. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
- e. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the Earth. (DOK 2)
- f. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to Earth’s geological history. (DOK 3)
  - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
  - Geological timetable
- g. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
- h. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the Earth. (DOK 1)

**4. Demonstrate an understanding of Earth systems relating to weather and climate.**

- a. Explain the interaction of Earth Systems that affect weather and climate. (DOK 1)
- Latitudinal variations in solar heating
  - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts)
- b. Interpret the patterns in temperature and precipitation that produce the climate regions on Earth and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
- c. Justify how changes in global climate and variation in Earth/Sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
- d. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
- e. Research and explain how external forces affect Earth's topography. (DOK 2) How surface water and groundwater act as the major agents of physical and chemical weathering How soil results from weathering and biological processes
- Processes and hazards associated with both sudden and gradual mass wasting
  - 
  - **5. Apply an understanding of ecological factors to explain relationships between Earth systems.**

- a. Draw conclusions about how life on Earth shapes Earth systems and responds to the interaction of Earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)

Nature and distribution of life on Earth, including humans, to the chemistry and availability of water

Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time

- Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy, and how
- human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)
-

- b. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
- c. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped Earth systems. (DOK 1)
  - Photosynthesis and the atmosphere
  - Multicellular animals and marine environments
  - Land plants and terrestrial environments
- d. Cite evidence about how dramatic changes in Earth's atmosphere influenced the evolution of life. (DOK 1)

## ENVIRONMENTAL SCIENCE

- one half credit -

*Environmental Science* is a laboratory-based or field-based course that explores ways in which the environment shapes living communities. Interactions of organisms with their environment should be emphasized along with the impact of human activities on the physical and biological systems of the Earth. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# ENVIRONMENTAL SCIENCE

- one half credit -

## CONTENT STRANDS:

Inquiry  
Earth and Space Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
  - Safety rules and symbols
  - Proper use and care of the compound light microscope, slides, chemicals, etc.
  - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

### EARTH AND SPACE SCIENCE

#### 2. Develop an understanding of the relationship of ecological factors that effect an ecosystem.

- a. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)

- b. Explain the flow of matter and energy in ecosystems. (DOK 2)
  - Interactions between biotic and abiotic factors
  - Indigenous plants and animals and their roles in various ecosystems
  - Biogeochemical cycles within the environment
- c. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
- d. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
  - How a species adapts to its niche
  - Process of primary and secondary succession and its effects on a population
  - How changes in the environment might affect organisms
- e. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
- f. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
- g. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

**3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.**

- a. Summarize the effects of human activities on resources in the local environments. (DOK 2)
  - Sources, uses, quality, and conservation of water
  - Renewable and nonrenewable resources
  - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
- b. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere and atmosphere and develop a logical argument to support how communities restore ecosystems. (DOK 3)
- c. Research and evaluate the use of renewable and nonrenewable resources and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

# GEOLOGY

- one half credit -

The *Geology* course provides opportunities for students to develop and communicate an understanding of the chemical and physical content of the Earth and the changes that can occur through field studies and concept exploration. Concepts covered in this course include Earth's internal components (identification and interaction), plate tectonics, the geological timetable, and Mississippi geological areas. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# GEOLOGY

- one half credit -

## CONTENT STRANDS:

Inquiry  
Earth and Space Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
  - Safety rules and symbols
  - Proper use and care of the compound light microscope, slides, chemicals, etc.
  - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

### EARTH AND SPACE SCIENCE

#### 2. Develop an understanding of plate tectonics and geochemical and ecological processes that affect Earth.

- a. Differentiate the components of the Earth's atmosphere and lithosphere. (DOK 1)
- b. Research and summarize explanations of how Earth acquired its initial

- atmosphere and oceans. (DOK 2)
- c. Compare the causes and effects of internal and external components that shape Earth's topography. (DOK 2)
    - Physical weathering (e.g., atmospheric, glacial, etc.)
    - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
  - d. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
    - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
    - Processes that create earthquakes and volcanoes
    - Asthenosphere
  - e. Summarize the theories of plate development and continental drift and describe the causes and effects involved in each. (DOK 2)
  - f. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy, and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers). (DOK 2)
  - g. Interpret how the Earth's geological time scale relates to geological history, landforms, and lifeforms. (DOK 2)
  - h. Research and describe different techniques for determining relative and absolute age of the Earth (e.g., index of fossil layers, superposition, radiometric dating, etc.) (DOK 1)
  - i. Summarize the geological activity of the New Madrid Fault line and compare and contrast it to geological activity in other parts of the world. (DOK 2)
  - j. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.) (DOK 1)
  - k. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

# ASTRONOMY

- one half credit -

The *Astronomy* course will provide opportunities for students to develop and communicate an understanding of astronomy through lab-based activities, mathematical expressions, and concept exploration. Concepts covered in this course include history of astronomy, technology and instruments, Kepler's and Newton's Laws, celestial bodies, and other components of the universe. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

The *Mississippi Science Framework* is comprised of three content strands: **Life Science, Earth and Space Science, and Physical Science**. The five process strands are **Science as Inquiry, Unifying Concepts and Processes, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science**. The three content strands, along with the five process strands, combine to provide continuity to the teaching of K-12 science. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum. **Science as Inquiry** is listed as a separate strand in order to place emphasis on developing the ability to ask questions, to observe, to experiment, to measure, to problem solve, to gather data, and to communicate findings. **Inquiry is not an isolated unit of instruction and must be embedded throughout the content strands.**

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

# ASTRONOMY

- one half credit -

## CONTENT STRANDS:

Inquiry  
Earth and Space Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
  - Safety rules and symbols
  - Proper use and care of the compound light microscope, slides, chemicals, etc.
  - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

### EARTH AND SPACE SCIENCE

#### 2. Develop an understanding of theories pertaining to the history of the universe and concepts related to the interaction of celestial bodies.

- a. Investigate and compare historical developments in astronomy to current knowledge of the universe. (DOK 2)
    - Observations that significantly contributed to the understanding of the solar system prior to the telescope's development and their impact on astronomy
    - Models to predict planetary motion (e.g., Ptolemy, Copernicus, Kepler, Newton) and their influence on modern astronomy
  - b. Research and summarize theories of the universe's origin. (DOK 3)
  - c. Differentiate and evaluate the significance of technologies and instruments used in ground and space-based astronomy (e.g., optical telescopes, radio telescopes, x-ray telescopes, long-base interferometers, space probes, artificial satellites, spectra, probes, Doppler radar, etc.) (DOK 2)
  - d. Research and develop a logical argument supporting or refuting current theories, proposals, and supporting data of celestial bodies in our solar system. (DOK 3)
  - e. Investigate Newton's Universal Gravitation Law and Kepler's Laws. (DOK 2)
    - and interactions of a planetary system according to Kepler's laws
    - Structure and gravitational interactions of a planetary system according to Newton's laws of motion and gravitation
  - f. Apply Newton's Universal Gravitation Law and Kepler's Laws to predict the orbital velocity of a given planet around the sun or a given moon around its primary and to calculate period, distance from the sun, and/or velocity of a planet. (DOK 2)
  - g. Compare and contrast celestial bodies in our solar system. (DOK 1)
    - Motion of celestial bodies (e.g., planetary rotation and revolution, comets, asteroids, moons, sun, etc.)
    - Internal and surface components of celestial bodies
    - Patterns of the Earth's moon over an extended period of time
    - Origin, composition and structure of asteroids, meteors and comets (e.g., the Ort cloud)
    - h. Investigate and demonstrate an understanding of the sun, other stars, and star systems. (DOK 3)
- Origin and demise of stars of various masses
- Star classification (by size and magnitude) and types of stars
  - Hertzsprung-Russell diagram (used to classify and describe the evolution of stars)
  - i. Research and differentiate the composition, energy production, and solar-magnetic activity of stars. (DOK 2)
  - j. Investigate and apply various methods to measure astronomical distances. (DOK 2)
- Triangulation (parallax) method
- Use of Cepheid variables
- Use of the red shift
  - k. Research to compare and contrast star systems visible from Earth. (DOK 2)
  - l. Describe the universe in terms of its diverse components and their relationships. (DOK 3)
- Types of galaxies, proximity of galaxies, the name of Earth's galaxy, etc.
-

- Components of the celestial sphere (e.g., dark matter, dark energy, pulsars, quasars, supernovae, hierarchical structure of the universe, galactic clusters, the “Great Wall”, etc.)
- m. Research and summarize theories about the structure of the universe (Big Bang, the inflationary era, microwave background radiation, and the importance of its anisotropies to galactic formation). (DOK 3)

# AEROSPACE STUDIES

- one half credit -

The *Aerospace Studies* course provides opportunities for students to develop and communicate an understanding of aerodynamics through lab-based activities, mathematical expressions, and concept exploration. Concepts covered in this course include aerodynamics, instrumentation, aircraft's propulsion, navigation, and history of flight. Laboratory activities allow students to observe and analyze aerodynamic situations as they relate to physical laws and concepts. Research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

# AEROSPACE STUDIES

- one half credit -

## CONTENT STRANDS:

Inquiry  
Earth and Space Science

## COMPETENCIES AND OBJECTIVES:

### INQUIRY

#### 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.) (DOK 3)

### EARTH AND SPACE SCIENCE

#### 2. Develop an understanding of the concepts involved in aerodynamics, flight control, and aircraft propulsion.

- a. Research and summarize the history of flight. (DOK 2)
  - Achievements of early aviators
  - Importance and modern applications of flight
  - b. Describe principles of aerodynamics and flight control. (DOK 2) Bernoulli effect
  - Aerodynamic forces (e.g., lift, weight, thrust, drag) and their effects on flight
- c. Cite examples and provide diagrams to explain how the location of center of gravity and other force centers affect flight stability. (DOK 2)

- d. Compare the various methods of aircraft propulsion. (DOK 2)
  - Operation of reciprocating and turboprop, (jet) engines
  - Development of aircraft propulsion systems
- e. Calculate the expansion ratio of gases in an engine (gas laws). (DOK 1)
- f. Use appropriate instruments and perform calculations involved in navigation (e.g., locating a point on the globe from its global coordinates and plotting a point-point course using a sectional map). (DOK 2)
- g. Research and summarize the design and function of major aircraft structures, instruments, and life support systems. (DOK 2)
  - Purpose of the airplane's structural components and instruments
  - Design, function, and use of various flight control surfaces
  - Function of life-support systems on aircraft

## SPATIAL INFORMATION SCIENCE

- one half or one credit -

*Spatial Information Science* encompasses the principles, theories and applications of spatial information systems (SIS). This course includes the use of SIS to explore, investigate, collect and analyze data, and present findings and recommendations on current problems through group and individual activities. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course.

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# **SPATIAL INFORMATION SCIENCE**

- one or one half credit -

## **CONTENT STRANDS:**

**Inquiry**  
**Earth and Space Science**

## **COMPETENCIES AND OBJECTIVES:**

### **INQUIRY**

#### **1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.**

- a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.) (DOK 3)

### **EARTH AND SPACE SCIENCE**

#### **2. Develop an understanding of geographic information systems.**

- a. Demonstrate the basic concepts of global positioning systems (GPS) by determining locations, (e.g., latitude, longitude, and elevation of the school flag pole or a site where a GPS receiver is unable to make an accurate measurement). (DOK 1)
- b. Calculate various angle units and the average and standard deviation from repeated measurements. (DOK 1)

- c. Explain the basic concepts of remote sensing. (DOK 2)
  - Characteristics of the electromagnetic spectrum
  - Passive versus active sensor systems
  - Types of sensor platforms
- d. Analyze the effects of changes in spatial, temporal, and spectral resolution and effects on images due to changes in scale. (DOK 2)
- e. Interpret the absorption/reflection spectrum using images and graphs. (DOK 2)
- f. Explain the basic concepts of data and image processing. (DOK 1)
  - Types of data (e.g., raster, vector, and attribute)
  - Variety of sources for geological data and imaging
- g. Formulate a hypothesis of geological factors/problems and determine data sets pertinent to the hypothesis. (DOK 3)
- h. Explain how data sets are geo-referenced and geo-rectified. (DOK 1)
- i. Assess the quality and accuracy of GPS and/or remote sensing data. (DOK 2)
- j. Analyze and apply the basic concepts of geographic information systems. (DOK 2)
  - Compatible geographic data layers of information utilizing computer software
  - Relationships between geographic data
  - Geographic information image showing results of analysis
- k. Draw conclusions based on analysis and summary of geographic image information results. (DOK 3)
- l. Research and defend a variety of applications for geographic information systems. (DOK 3)
- m. Describe the proper use and care of GPS receivers, computers, and other scientific equipment. (DOK 1)
- n. Assess image problems and demonstrate the ability to adjust equipment to obtain correct, and clear data images. (DOK 1)

## FIELD EXPERIENCES

- one half credit -

Field Experiences may be added to any high school level science course given a time allotment equivalent to one semester is used for laboratory or field-based instruction. Each district creates the curriculum for the course.

**1. How many Carnegie units may be added when the Field Experiences option is used?**

1/2 units

**2. May a school enroll a student in Field Experiences as independent study? No.**

The school must schedule Field Experiences as an addition to a high school science course as stated in the definition above. Students in that class must be enrolled in Field Experiences throughout the science course to which it is attached.

**3. May time outside the normal 8:00 - 3:00 school day be counted for Field Experiences?**

Time after the normal school day or weekends may be used for the Field Experiences option. Attendance for these sessions must be documented following the district attendance policy; therefore, any after-school or weekend program would be required and not optional.

**4. May other instructors or guest speakers be used in the Field Experiences program?**

This is an option; however, students must always be under the direct supervision of a certified teacher.

**5. Should parents be given information if their children are enrolled in a high school course using the Field Experiences option?**

Absolutely. Parents should be informed of the added expectations of the course including a complete schedule of any activities beyond the normal school day.

**6. What amount of time in hours is equivalent to a time allotment of one semester?**

An excess of 70 hours of instruction would constitute one semester.

**7. What should the district consider before using the Field Experiences option?**

- Student travel expenses should be provided for all students because Field Experiences is a part of the academic program and receives Carnegie unit credit.
- Teachers should not be expected to teach a normal class load in addition to Field Experiences without compensation.
- Additional laboratory equipment and supplies may be needed for Field Experiences.
- Students should not be enrolled in Field Experiences at the expense of elective courses or programs in disciplines other than science.

**8. May a student use the Field Experiences option more than once?** Yes, provided the Field Experiences option is added to a different high school course.

**9. May a student take the same course without Field Experiences and with Field Experiences? (Ex. Geology and Geology with Field Experiences).** No

**10. May Field Experiences be added to a Vocational, MSMS, or International Baccalaureate course?**

No. Field Experiences may only be used for high school courses listed by competency in the Mississippi Science Framework and for Advanced Placement Science courses.

## **SUGGESTED SCIENCE EQUIPMENT AND SUPPLIES (Grades K-4)**

Balance Scales  
Batteries  
Beakers  
Calculators  
Compass  
Computer  
Filters  
Fire Extinguisher  
First-Aid Kit  
Flashlights  
Funnels  
Graduated cylinders  
Hand magnifying lens  
Hot plate Magnets  
Medicine droppers  
Meter sticks  
Metric rulers  
Metric weights  
Microscope  
Mirrors  
Non-mercury Thermometers  
Pans and Buckets  
Petri dishes  
Ph Indicators  
Plastic tubing (flexible and nonflexible)  
Popsicle sticks  
Prism  
Protractors  
Rock and Mineral samples  
Safety goggles  
Scissors Slide kits  
Small and large bulbs  
Spring scales  
Stop watch  
Tape measure  
Test tubes  
Tuning forks  
Weather Instruments  
Wire  
Wooden blocks

## **SUGGESTED SCIENCE EQUIPMENT AND SUPPLIES (Grades 5-6)**

Alcohol	Packing Peanuts
Alcohol thermometers	Pans
Baking soda	Petri Dishes
Balloons	pH indicators
Batteries	Pipe Cleaners
Beakers	Pipettes
Buckets	Plastic cups
Calculators	Plastic spoons/scoops
Colored filters	Plastic wrap
Compasses	Prisms
Computers	Protractors
Convex and Concave lenses	Ring stands
Copper Wire	Rock/mineral samples
Corn starch	Rubber bands
Cotton swabs	Sand
Craft sticks	Simple machines
Disposable Gloves	Slinky
Dried beans	Snips or Scissors
Electronic balance	Spring goggles
Electrical switches	Stoppers
Filters	Stop watches
Fire extinguisher	Straws
First Aid Kit	Styrofoam Plates
Flashlights	Sugar
Food coloring	Tape measures
Foil	Test tubes and test tube racks
Freezer bags	Triple beam balance
Funnels	Tuning Forks
Glycerine	Vinegar
Graduated cylinder	Weather Instruments
Hand lenses	Wooden blocks
Hot plate	
Hot wheel cars	
Hydrogen Peroxide	
Iron Filings	
Lab aprons	
Light bulbs	
Magnets	
Meter Sticks	
Metric rulers	
Metric weights	
Microscope	
Mirrors	

## **SUGGESTED SCIENCE EQUIPMENT AND SUPPLIES (Grades 7-8)**

Alcohol thermometers  
Anatomy models  
Batteries  
Beakers  
Blank slides  
Buckets  
Calculators  
Cell models  
Celsius thermometers  
Compasses  
Computers  
Concave lenses  
Convex lenses  
Copper wire  
Disposable gloves  
Electrical switches  
Fahrenheit thermometer  
Filters  
Fire extinguisher  
First Aid Kit  
Flashlights  
Funnels  
Glass tubing  
Graduated cylinders  
Hand magnifying lens  
Heat source  
Hose/tubing  
Insulated wire  
Lab aprons  
Light bulbs/holders  
Magnets (bar, horseshoe, ceramic)  
Magnifying glasses  
Medicine droppers  
Meter sticks and metric rulers  
Metric weights  
Microscopes  
Mineral test kits  
Mirrors  
Pans  
Periodic tables (individual and wall)  
pH indicators  
Pipe cleaners  
Plant models  
Plastic spoons  
Prisms  
Protractors  
Rock/mineral samples  
Safety goggles  
Simple machines  
Slide kits  
Slinkies  
Snip/Scissors  
Spring scales  
Stoppers  
Stop watches  
Stream table  
Styrofoam ball (various sizes)  
Tape measures  
Telescopes  
Test tubes holders  
Test tubes  
Triple beam balances  
Tuning forks  
Weather instruments  
Wire stripper  
Wooden blocks

## SUGGESTED EQUIPMENT AND SUPPLIES (Physical Science)

Alligator Clips	Simple pulleys
Balance	Small DC motors
Balloons	Stirring Rods
Beakers	Stopwatches
C- or D- cell battery holders	Test tube supports
Calorimeters	Test tubes
Candles	Toothpicks
Celsius Thermometers	Toy cars
Circuit Boards	Transfer pipets
Concave mirrors	Triple beam balance
Conductivity indicators	Tuning Forks
Convex mirrors	Watch Glasses
Density cylinder set	Wire stripper/cutter
Dispensing bottles	Wool and silk squares
Electroscopes	
Evaporation Dishes	
Filter paper	
Flashlights (light source)	
Funnels	
Gloves for various purposes	
Graduate Cylinders	
Gumdrops (marshmallows, etc.)	
Heat source (hot plate, bunsen burner, etc)	
Inclined planes (with pulley)	
Lab size Slinkies	
Lenses (convex and concave)	
Lens holders	
Litmus paper	
Long springs	
Marbles	
Mass hangers and weights	
Meter sticks	
Meter stick holders	
Metric rulers	
Miniature compasses	
Organic molecule sets	
pH paper	
Periodic Table	
Plastic and glass rods	
Plastic tubs	
Pulley mount clamps	
Resistors	
Ring stand setup Round	
Magnets (whole)	
Safety goggles	

## SUGGESTED EQUIPMENT AND SUPPLIES (Chemistry)

### *Laboratory Group Items*

Aprons, safety	Lighter, flint
Aspirators, vacuum	Loop, nichrome wire/flame test
Balances, triple beam	Meter stick
Beakers*	Molecular model set
Bottles, dropper	Mortar and pestle
Bottles, gas generating	Paper, filter
Bottles, plastic water bottles	pH meter
Bottles, reagent	Pipet, measuring
Boyles Law Apparatus**	Pipet, transfer
Brushes, test tube	Pipets, Beryl type, thin stem
Bulb, pipet	Pipets, Beryl type, microtype
Burets	Racks, test tube
Bunsen Burner (with tubing)	Rings
Calorimeter	Rods, glass stirring
Chart, periodic (wall size)	Spatulas
Clamp, thermometer	Spectroscope, student handheld
Clamps, burets (single and double)	Splints, wood
Clamps, test tube	Stand, rings
Conductivity device (battery operated)	Stoppers
Crucibles (with cover)	Stopwatch
Cylinders, graduated*	Thermometer, room
Desiccator	Thermometer, alcohol filled, student
Dishes, evaporating	Tongs, beaker
Flask, Erlenmeyer*	Tongs, crucible
Flask, Volumetric*	Triangles, crucible
Flask, Culture	Trough, pneumatic
Funnel, filter	Tube, gas collection
Gauze, wire (with ceramic center)	Tubes, test
Glasses, watch	Tubing, glass
Gloves, safety	Tubing, rubber
Goggles, safety	Well plates, micro*
Holder, filter funnel	

### *Classroom/Laboratory Items*

Balances, electronic centigram	Hot plate/magnetic stirrer
Barometer (mercury or aneroid)	Microwave
CBL™ or LabPro™ units/probes/software	Orbital model set
colorimeter	Oven, drying
pH strips	Power supply, spectrum tubes
pressure sensor	Refrigerator
temperature or	Software, computer
colorimeter/spectrophotometer/and	Spring, long
pH meter	Tubes, spectrum

**Purchase chemicals as needed in small quantities on a yearly basis.**

\* Variety of sizes according to curricular needs

\*\* Consider microscale alternatives (see suggested strategies)

## SUGGESTED EQUIPMENT AND SUPPLIES (Biology)

Assorted prepared slides	Plastic pipets
Autoclave	Refrigerator
Beakers	Ring stand
Benthic sampler	Safety goggles
Biological stains	Scalpel blades
Blank Slides	Scalpel handle
Blunt probes	Scissors
Burner tubing	Secchi disks
CBL with probes and software	Stereomicroscopes
Compound Microscopes	Stoppers
Concave slides	Teasing needles
Cotton swabs	Test kits
Culture dishes	Test tube holders
Dialysis tubing	Test tube racks
Disposable gloves	Thermometers (non mercury)
Dissecting pan	Tirrill burners
Dropper bottles	Tongs
Electrophoresis chambers	Triple beam balances
Electronic balances	Transparent ruler
Erlenmeyer flasks	Trowels
Flexcam	Wash bottles
Forceps	Water bath
Funnels	Water sampler
Glass stirring rods	
Graduated cylinders	
Graduated pipettes	
Hot plates	
Incubator	
Lens paper	
Life-size human skeleton model	
Magnifier	
Meter sticks	
Micropipettes	
Microwave	
Mortar and pestle	
Periodic table	
Petri dishes (plastic)	
pH meter	
Pipette bulbs or pumps	
Plankton net	
Plant press	

**\*Purchase chemicals as needed in small quantities on a yearly basis.**

## SUGGESTED EQUIPMENT AND SUPPLIES (Physics)

20MHz Oscilloscope (with probes)	Resistors (assorted)
AC/DC power supply	Resonance box
Alligator Clips	Round magnets (with hole)
Balloons	Screen holders
Bathroom scale (with kg markings)	Silicon solar cells
Beakers	Sine wave oscillator
C- and D- cell battery holders	Single pulleys
Calorimeters	Small bulbs with sockets
Candles/matches	Small DC motors
CdS photocells	Speaker/Amplifier
Celsius thermometers	Specific gravity sets
Clear protractors	Spectrum tubes
Diffraction grating slides	Spectrum tube power supply
Digital volt/ohm meters	Spring scales
Diodes	Springs
Electroscopes	Stands
Extra strength magnets	Stopwatches
Flashlights	Switches
Forces tables	Transformers
Glass blocks and prisms	Triple beam balances
Hall carriages	Tuning forks
Hand-cranked generator	Vernier calipers
Hand-powered vacuum pump	Wire stripper/cutters
Hotplate Wool and silk squares	
Inclined planes (with pulley)	
Lab size slinky	
LASER (pointers will work)	
Lenses (concave and convex)	
Lens holders	
Long springs (wave generator)	
Marbles	
Mass hangers and weights	
Meter sticks	
Meter stick holder	
Metric rulers	
Microphones	
Miniature compasses	
Mirrors (concave and convex)	
Multimeters	
Non-polarized capacitors	
Plastic and glass rods	
Plastic tubs	
Power cords	
Pulley mount clamps	
Pulley strings	

## Science Safety

The guides that are cited below were developed by the Council of State Science Supervisors (CSSS) with support from the Eisenhower National Clearinghouse for Mathematics and Science Education, the National Aeronautics and Space Administration, Dupont Corporation, Intel Corporation, American Chemical Society, and the National Institutes of Health. Science Safety Booklets may be printed for use by educators.

### Science Safety Booklets

- [Science and Safety: It's Elementary](#) (PDF) - A Elementary Safety Guide
- [Science and Safety, Making the Connection](#) (PDF) - A Secondary Safety Guide

## A SUGGESTED PATTERN FOR CHEMICAL STORAGE

The alphabetical method for storing chemicals presents hazards because chemicals, which can react violently with each other, may be stored in close proximity. Schools may wish to devise a simple color-coding scheme to address this problem. The code shown below, reproduced with permission from School Science Laboratories-A Guide to Some Hazardous Substances by the Council of State Science Supervisors, includes both solid and striped colors which are used to designate specific hazards as follows:

Red	- Flammability hazard: Store in a flammable chemical storage area.
Red Stripe	- Flammability hazard: Do not store in the same area as other flammable substances.
Yellow	- Reactivity hazard: Store separately from other chemicals.
Yellow Stripe	- Reactivity hazard: Do not store with other yellow coded chemicals; store separately.
White	- Contact hazard: Store separately in a corrosion-proof container.
White Stripe	- Contact hazard: Not compatible with chemicals in solid white category.
Blue	- Health hazard: Store in a secure poison area.
Orange	- Not suitably characterized by any of the foregoing categories.

Once the chemicals are sorted according to their color-coded hazards, sorting into organic and inorganic classes within a color should occur. The Flinn Chemical Catalog Reference Manual suggests organic and inorganic groupings that are further sorted into compatible families. For a FREE Reference Manual with the most current information, please contact Flinn at 1-800-452-1261.

Protective eyeglasses/safety goggles are required for every student enrolled in elementary and secondary science courses while participating in chemical-physical laboratory activities (MS Code 37-11-49).

## LABORATORY/CLASSROOM SAFETY EQUIPMENT

Acid cabinet  
 Broken glass container  
 Eyewash fountain (not plastic squeeze bottle station)  
 Fire extinguishers (powder)  
 First aid kit  
 Fume hood  
 MSDS sheets (book)  
 Safety poster and contracts  
 Safety shower  
 Sand and buckets  
 Solvent cabinet

## DANGEROUS CHEMICALS

The following lists reference chemicals that exhibit either *extremely* dangerous or *unusually* dangerous characteristics. These lists only reference chemicals that are more commonly found in laboratories and are by no means a complete list of dangerous chemicals. Teachers and administrators should always weigh the potential scientific usefulness against the potential hazards of **all** chemicals before ordering, storing or using them.

### Chemicals that exhibit extremely dangerous characteristics and are not recommended for use in high school laboratories:

**Antimony and its compounds** - Toxic if inhaled, swallowed, or absorbed through the skin.

**Benzene** - Carcinogenic.

**Benzoyl Chloride** - When heated it releases phosgene gas. Reacts violently with water.

**Benzoyl Peroxide** - Poisonous and severe explosion hazard.

**Carbon Disulfide** - Extremely flammable and poisonous, eye and lung irritant, potentially explosive.

**Chlorine (Gas)** - Corrosive and extremely poisonous.

**Dinitrophenol/2,4-Dinitrophenol** - Very poisonous. When dry it becomes explosive and shock sensitive.

**Ethylene Oxide (Gas)** - Extremely flammable and poisonous.

**Hydrofluoric (HF) Acid** - Extremely corrosive and toxic. Exposure may be fatal without immediate and very specialized first aid treatment. HF should never be stored or used in high school laboratories.

**Hydrogen (Gas)** - Extremely flammable.

**Hydrogen Chloride, Anhydrous (Gas)** - Extremely corrosive and poisonous.

**Hydrogen Sulfide (Gas)** - Flammable and extremely poisonous.

**p-Dioxane** - Extremely flammable and may present a severe explosion hazard.

**Perchloric Acid** - Poisonous and severe explosion hazard.

**Phosphorous, White/Yellow** - Flammable solid, toxic. Auto-ignites at 86 degrees Fahrenheit when exposed to air.

**Picric Acid** - When dry it becomes explosive and shock sensitive.

**Potassium Metal** - Flammable solid. Reacts violently with water. May form peroxides on the outer skin. Sodium metal is a safer alternative.

**Sulfur Dioxide (Gas)** - Corrosive and poisonous.

**Thermit** - Explosion hazard.

#### Generic Listings:

\*Compounds that exhibit severe explosion hazards

\*Poisonous gases

\*Compounds that have potential to decompose violently at normal room temperature

\*Perchlorates, Azides, Styphnates, Radioactive Compounds

**Chemicals that exhibit unusually dangerous characteristics and are not normally recommended for use in high school laboratories except in very small quantities and only when necessary for scientific reasons:**

**Ammonium dichromate** - toxic, flammable, explosive with organic compounds.

**Bromine** - Very corrosive and poisonous.

**Ethyl Ether** - Extremely flammable. Has potential to form explosive peroxides that may result in a shock-sensitive compound. Never store beyond expiration dates.

**Mercury, elemental** - Poisonous. Spills can be very difficult and expensive to clean up.

**Potassium/Sodium Cyanide** Extremely poisonous.

**Sodium Metal** - Flammable solid. Reacts violently with water.

**Generic Listings:**

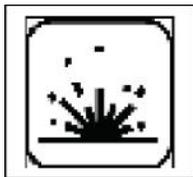
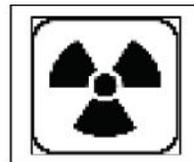
\*Compounds that are unusually poisonous, air/water reactive or otherwise unstable.

\*Acute hazardous wastes (P-listed) as defined in 40 Code of Federal Regulations (CFR) Part 261.33.

\*Compounds that have potential to form explosive peroxides.

\*For additional chemical hazards, see Flinn's List of Devils in their FREE Reference manual.

# Common Safety Symbols\*

**Flammable****Poison****Explosive****Radioactive****Corrosive****Compressed Gas****Low Level Hazard****Severe Chronic Hazard**

\*Globally Harmonized System of Classification and Labeling of Chemicals,  
United Nations New York and Geneva, 2005

## Glossary

The following definitions cover the major terms associated with assessment and the curriculum guide.

**Advanced placement (AP) course** - a high school course that provides curriculum which is accelerated and often equated with college level material. (Note: AP courses usually follow, rather than substitute for, courses of similar content. For example, AP Biology should follow Biology I and should not substitute for Biology I. AP curriculum and assessment are determined by The College Board. <http://www.collegeboard.com/student/testing/ap/subjects.html>).

**Assessment** - method(s) to determine the extent to which curricular goals are being or have already been achieved.

**Attribute** - a characteristic; students are asked to group objects according to such attributes as color, size, shape, or other identifiable characteristics.

**Change** - the process of becoming different.

**Classify** - a method for establishing order on collections of objects or events. Students use classification systems to identify objects or events, to show similarities, differences, and interrelationships. It is important to realize that all classification systems are subjective and may change as criteria change; the test for a good classification system is whether others can use it.

**Communicate** - the transmission of observable data; examples include spoken or written words, graphs, drawings, diagrams, maps, mathematical equations; skills such as asking questions, discussing, explaining, reporting, and outlining can aid in the development of communication skills.

**Concept** - an abstract, universal idea of phenomena or relationships between phenomena in the natural world.

**Constancy** - remains the same, such as the speed of light.

**Control** - a standard condition against which other conditions can be compared in a science investigation;

**Controlled variable** - the conditions that are kept the same in a scientific investigation.

**Describe** - the skill of developing a detailed picture, image, or characterization using diagrams and/or words, written or aural.

**Design** - the application of scientific concepts and principles and the inquiry process to the solution of human problems that regularly provide tools to further investigate the natural world.

**Dichotomous key** - a strategy used in classification that involves placing objects in groups (or eliminating them) based on certain characteristics.

**Environment** - all external conditions and factors, living and non-living, that affect an organism during its life time.

**Equilibrium** - a physical state in which forces and changes occur in opposite and offsetting directions. For example, opposite forces are the same magnitudes or offsetting changes occur at equal rates.

- Essential Understandings** – the “big ideas” related to the critical concepts and topics of a study. Essential understandings stretch beyond discrete facts or skills and focus on larger concepts, principles or processes.
- Empirical** – measurements based on actual observations or experience, rather than on theory.
- Evidence** – consists of observations and data on which to base scientific inquiry.
- Evidence-based decisions** – decisions made by students after they have reviewed sufficient information on a topic or issue, both negative and positive.
- Evolution** – a series of changes, some gradual and some sporadic, that accounts for the present form and natural and designed systems.
- Examine** – the skill of using a scientific method of observation to explore, test, or inquire about a theory, hypothesis, inference, or conclusion.
- Explanation** – includes a rich scientific knowledge base, evidence of logic, higher levels of analysis, greater tolerance of criticism and uncertainty, and a clear demonstration of the relationship between logic, evidence, and current knowledge.
- Experiment** – testing a hypothesis under controlled conditions; basic to the total scientific process; uses all process skills.
- Explain** – the skill of making a theory, hypothesis, inference, or conclusion plain and comprehensible. It includes supporting details with an example.
- Fact** – a thing that has actually happened or that is really true.
- Framework** – a blueprint of curriculum content and student learning objectives for a specific course of study.
- Field Experiences** – see pages 138-139.
- Hypothesis** - forming a generalization / question based on observations; involves asking questions, making inferences and predictions; must be testable/tested to establish credibility.
- Idea** – a general perception, thought, or concept formed by generalization.
- Indicator** – a specific description of an outcome in terms of observable and assessable behaviors. An indicator specifies what a person understands or can do. For example, a student may demonstrate his or her understanding of problem solving by finding a solution to a problem in biology. The correct answer is an indicator.
- Infer** – using logic to draw conclusions from observations; suggests explanations, reasons, and/or causes for events; based on judgments; and may not always be valid.
- Inquiry** – a set of interrelated processes by which students and scientists pose questions about the natural world and investigate phenomena; a critical component of a science program at all grade levels and in every domain of science; allows students to learn science in a way that reflects how science actually works.
- Interpreting data** – integrated process skill; involves making predictions, inferences, and hypotheses from a set of data; revision of interpretations may be necessary when additional data are obtained.
- Investigations** – investigations provide students with the opportunities to frame and or in small groups or teams. They plan their work and select processes and equipment with attention to safety and draw conclusions from their data. They comment on the accuracy and reliability of the processes used and data collected, and complete a report of their investigation which can be presented in a range of formats.
- Justify** – to prove or show something to be right, just or reasonable; to support, argue for, defend, prove.

**KWL** – measure the knowledge acquired by students using student responses to the following questions:

K - What do I know?

W - What more do I want to know?

L - What have I learned?

**Laboratory Report** – a written report which may include purpose, observations (including numeric data), calculations, analysis (including sources of error) and conclusions drawn from student performed activities.

It should be evaluated by a rubric.

**Law** – an observed regularity of the natural world; a generalization that scientists make from research findings and can use to accurately predict what will happen in many situations.

**Manipulated variable** – The factor of a system being investigated that is deliberately changed to determine that factor’s relationship to the responding variable.

**Mass** – Mass and weight are not the same. In science these words have special meanings. Mass is a measure of the amount of matter (material) in an object and is commonly measured in grams (g) or kilograms (kg).

**Material Safety Data Sheets (MSDS)** – MSDS provide the information needed to allow the safe handling of hazardous substances used at the workplace. Schools are required to comply with these procedures for the management of hazardous substances. A MSDS should provide sufficient information to enable users of the hazardous substances to handle them safely, to understand their potential dangers and to take appropriate action in case of an emergency.

**Measurement** – scientists generally use the International System of Measurement (SI) or metric system.

**Measure** – ordering of things by magnitude, such as area, length, volume, mass; processes to quantify observations; involves the use of instruments and the skills needed to use them effectively.

**Model** – tentative schemes or structures that correspond to real objects, concepts, events, or classes of events and have explanatory power. Models help scientists and engineers understand how things work.

**Nature of science** – incorporates the historical development of science, habits of mind that characterize science, and methods of inquiry and problem solving.

**Nature of technology** – encompasses the issues of design, application of science to real-world problems, and trade-offs or compromises that need to be considered for technological solutions.

**Non-standard measurement** – measuring using materials such as paper clips, different sized scoops of rice, thumbprints, footsteps, etc.

**Observe** –using one or more of the senses in perceiving properties or similarities and differences in objects and events; can be made directly with the senses or indirectly through the use of simple or complex instruments; influenced by the previous experience of the observer.

**Order** – the behavior of units of matter, objects, organisms or events in the universe. This can be described statistically.

**Organization** – provide useful ways of thinking about the world. Examples include the Periodic Table of Elements and the classification of organisms.

**Organisms** – any form of life.

**Phenomena** – events or objects occurring in the natural world.

- Predict** – suggesting what will occur in the future; based on observations, measurements, and inferences about relationships between or among observed variables; speculation of what will happen based on past experiences; accuracy of a prediction is affected by the accuracy of the observation; conjecture about how a particular system will behave, followed by observations to determine if the system did behave as expected within a specified range of situations.
- Problem solving** – the ability to approach a situation in which a goal is to be reached and to design one or more appropriate causes of action to reach that goal. Properties: The basic or essential attributes shared by all members of a group.
- Science** – the systematized knowledge of the natural world derived from observation, study, and investigation; also the activity of specialists to add to the body of this knowledge.
- Scale** – the range of scores possible on an individual item or task. Performance assessment items are typically scored on a 4 to 6 point scale, compared to a scale of 2 (right/wrong) on multiple-choice items.
- Science process skills** – those skills that allow students to observe, classify, measure, use time/space relationships, infer, predict, control variables, interpret data, formulate hypotheses, define operationally, and experiment.
- Scientific Inquiry** – involves making observations; posing questions; examining sources of information for facts; planning investigations; reviewing experimental evidence gathered by the student; using tools; proposing answers, explanations and predictions; and communicating results.
- Scientific method** – involves the principles and empirical processes of discovery and demonstration of considered characteristics of, or necessary for, scientific investigation. Scientific method generally involves the observation of phenomena, the formulation of a hypothesis concerning the phenomena, experimentation to prove or disprove the hypothesis, and a conclusion that validates or modifies the hypothesis.
- Skepticism** – the attitude in scientific thinking that emphasizes that no fact or principle can be known with complete certainty; the tenet that all knowledge is uncertain.
- Standard measurement** – measuring using standard metric or English tools.
- System** – an organized group of related objects or components that form a whole.
- Technology** - Creates products to meet human needs by applying scientific principles. Science and technology are reciprocal. Science helps drive technology. Technology is essential to science, because it provides instruments and techniques that promote scientific inquiry.
- Theory** – an always tentative explanation of phenomena that we observe; never proven; representative of the most logical explanation based on currently available evidence; becomes stronger as more supporting evidence is gathered; provides a context for predictions.
- Trials** – repetitions of data collection protocols in an investigation.
- Tools** – objects used to achieve a goal, to make an observation, and extend the senses
- Validity** – an indication of how well an assessment actually measures what is supposed to be measured rather than extraneous features. For example, a valid assessment of scientific problem solving would measure the students' ability to solve a problem and not the ability to read the problem.

**Weight** – The response of mass to the pull of gravity. Weight is a measure of force. Note: Weight is often confused with mass. Mass is the amount matter (stuff) an object has and is not dependent on the object's location. Weight is a measure of force and is not constant because the pull of gravity on an object's mass varies with location. An object would weigh less on Earth than on Jupiter because Jupiter has greater mass than Earth; Jupiter's mass would have a greater gravitational attraction for the object.