Subject Area Testing Program
(SATP2)

Biology I Blueprint-Interpretive Guide

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Subject Area Testing Program, Second Edition
Biology I Blueprint Interpretive Guide

A Joint Publication

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1.0 Purpose Statement

The Biology I assessment blueprint contain information about the make-up of the assessment, including the assessment strands, competencies, and objectives. In addition, the blueprint identifies the number objectives per strand/competency, the number of scored items per strand/competency, and number of raw score points per competency. The blueprint serves as a roadmap for creating and selecting items and constructing the test form. The blueprint is used throughout the framework cycle of the assessment and is used in constructing the test forms for each administration.

1.1 Blueprint Design Overview

The Biology I Test Blueprint (Appendix A) is developed to align with the Biology I competencies and objectives in the *2010 Mississippi Science Framework* (Appendix B: Biology I extracted). The Biology I assessment is aligned to the Biology I competencies in the framework. The Test Blueprint guiding the development of the Biology I End-of-Course (EOC) assessment delineates how the sixty (60) scored items on the test are dispersed throughout the competencies. The *2010 Mississippi Science Framework* (http://www.mde.k12.ms.us/docs/curriculum-and-instructions-library/2010-science-framework.pdf?sfvrsn=4) is comprised of three content strands and five process strands; however, the Biology I assessment is developed based on two of the content strands and one of the process strands:

- Inquiry,
- Physical Science, and
- Life Science.

The remaining process strands are not listed separately throughout the frameworks; however, should be incorporated into the content. Under each of the tested strands, the blueprint

delineates the competencies that will be measured. The Blueprint details how many objectives are associated with each competency and the number of items assessed per competency. Not all objectives are assessed on each form. More detailed information about the SATP2 Biology I assessment can be found in the SATP2 Technical Manuals, the Student-Parent Information Guide, and the Biology I Teacher Guide (latest publications for the 2015-2016 administrations).

Table 1.2 Interpreting the Blueprints

	Column A	Column B	Column C	Column D
Row # 1	**Strand Competency Objective**	**Objectives**	**Total Open ended (MC) Items**	**Total RS Points**
Row # 2	***Inquiry***	***7***	***7***	***0***
Row # 3	**1. Inquiry- Apply inquiry-based and problem-solving processes and skills to scientific investigations.**	7	7	
Row # 4	a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)			

- Row # 1 includes
    - headings that indicate the strand,
    - competencies,
    - objectives,
    - number of objectives per strand/competency,
    - total number of scored multiple choice items, and
    - total raw score points per strand/competency.
- Row # 2 identifies

- the assessment or content strand
    - delineated by bold and italicized print.

- Row # 3 identifies
    - the competency number,
    - the competency,
    - the number of objectives assessed per competency,
    - the number of scored multiple-choice items per competency, and
    - the total raw score points per competency.
- Row # 4 identifies
    - the objective alphabet,
    - the objective, and
    - the DOK at which the objective is assessed.
- Column A identifies
    - the strand,
    - competency number,
    - a description of the competency, and
    - the objective alphabet,
    - the objective, and
    - the DOK at which the objective is assessed.
- Columns B identifies
    - the number of objectives per strand, and
    - the number of objectives per competency.
- Column C identifies

- the number of scored items per strand, and
- the number of scored items per competency.

- Column D identifies
  - the number of raw score points per strand, and
  - the number of raw score points per competency.

1.3 Calculating Scores

Two types of scores are used for reporting student results: Raw Scores and Scale Scores. The raw score is the number of points earned per competency, which equates to the number of questions a student answers correctly. Item scores within each strand are summed to produce raw scores for each of the strands. This raw score alone has no meaning about a student's level of performance; therefore, is converted to a scale score. Scale scores are statistical conversions of raw scores that adjust for variations in the difficulty of items in different test forms and permit valid comparison across all test administrations. The scale score is the number the student receives that identifies the student's level of performance as either advanced, proficient, basic, or minimal. The scale score is also the number used to determine if the student passes the Biology I assessment.

1.4 Item Type

1.4.1 Multiple-choice

All items on the Biology I assessment are multiple-choice items. Multiple-choice items are an efficient way to assess knowledge and skills, and they can be developed to measure each of the cognitive targets. A well-designed multiple-choice item contains a stem that clearly presents the question to the student. Item stems are written in the form of a question. An introductory statement that provides additional context may precede the stem. The stem is

followed by four answer choices or options with only one plausible correct option. The other three options are clear distractors but are not options designed to trick the student. Answer options do not include such choices as "none of the above," "both A and B," and "all of the above." In addition, each item on the assessment is assigned a performance level descriptor (PLD) of either advanced, proficient, basic or minimal. A certain percentage of the core items on an assessment must be at the advanced, proficient, and basic levels in order to assess the full range of the performance levels.

2.0 Strands and Competencies

The blueprints for the Biology I EOC assessment indicate the number of items that will be written to each strand and competency. The Biology I assessment is comprised of six competencies and each test item correlates to one of the competencies. The total number of items assessed per strand and competency varies. Whenever possible, all objectives within a competency should be covered on the assessment when the total number of points for a competency allows it. Advisory committees comprised of Mississippi science educators participated in the development of the blueprints. These educators utilized their expertise to assist with determining the number of items assessed per competency.

2.1 Inquiry

2.1.1 Inquiry - Items written to measure the Inquiry competency are written to measure a student's ability to 1) apply inquiry-based and problem solving processing and skills to scientific investigations.

2.2 Physical Science

2.2.1 Biochemical Basis of Life - Items written to measure the Biochemical Basis of Life competency are written to measure a student's ability to 1) describe the biochemical basis of life and explain how energy flows within and between the living systems.

2.3 Life Science

2.3.1 – Living Organisms and Their Environment - Items written to measure the Living Organisms and Their Environment competency are written to measure a student's ability to 1) investigate and evaluate the interaction between living organisms and their environment.

2.3.2 – Biological Organization - Items written to measure the Biological Organization competency are written to measure a student's ability to 1) analyze and explain the structures and function of the level of biological organization.

2.3.3 – Heredity - Items written to measure the Heredity competency are written to measure a student's ability to 1) demonstrate an understanding of the molecular basis of heredity.

2.3.4 – Diversity and Biological Change - Items written to measure the Diversity and Biological Change competency are written to measure a student's ability to 1) demonstrate an understanding of principles that explain the diversity of life and biological evolution.

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Appendix A

Biology I Blueprint

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Biology I Blueprint

Strand Competency Objective	Objectives	Total Open-ended (MC) Items	Total RS Points
Inquiry	***7***	***7***	***7***
1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.	***7***	***7***	***7***
a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)			
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. (DOK 2)			
d. Construct and analyze 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	***7***	***7***	***7***
2. Describe the biochemical basis of life and explain how energy flows within and between the living systems.	***7***	***7***	***7***
a. Explain and compare with the use of examples the types of bond formation between or among atoms. (DOK 2)			
b. Develop a logical argument defending water as an essential component of living systems. (DOK 2)			
c. Classify solutions as acidic, basic, or neutral and relate the significance of the pH scale to an organism's survival. (DOK 2)			
d. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)			
e. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)			
f. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)			

Strand Competency Objective	Objectives	Total Open-ended (MC) Items	Total RS Points
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)			
Life Science	***16***	***46***	***46***
3. Investigate and evaluate the interaction between living organisms and their environment.	***3***	***11***	***11***
a. Compare and contrast the characteristics of the world's major. (DOK 2)			
b. Provide examples to justify the interdependence among environmental elements. (DOK 2)			
c. Examine and evaluate the significance of natural events and human activities on major ecosystems. (DOK 2)			
4. **Analyze and explain the structures and function of the levels of biological organization.**	***4***	***14***	***14***
a. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)			
b. Differentiate between types of cellular reproduction. (DOK 1)			
c. Describe and differentiate among the organizational levels of organisms (DOK 1)			
d. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants. (DOK 1)			
5. Demonstrate an understanding of the molecular basis of heredity.	**4**	**14**	14
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)			
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. (DOK 2)			
d. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)			
6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.	***5***	***7***	*7*

Strand Competency Objective	Objectives	Total Open-ended (MC) Items	Total RS Points
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)			
b. Critique data used by scientists 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 and applications of speciation. (DOK 3)			
e. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)			

Note: MC = Multiple Choice; RS = Raw Score

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Appendix B

2010 Mississippi Science Biology I Frameworks

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.

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.

BIOLOGY I

- one credit -

CONTENT STRANDS:

Inquiry **Physical Science**
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 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)

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Appendix C

Distribution of Performance Level Descriptors

Table 2-6. Distribution of items across PLD level

Performance Level Descriptor	Percentage of Items
Advanced	12% - 15%
Proficient	65% - 70%
Basic	15% - 18%
Must Equal	100%

Source: 2012-2013 Test Construction Specifications