ARKANSAS

K-12 SCIENCE STANDARDS

EDUCATION FOR A NEW GENERATION

Accelerated Science Course Pathway

Biology - Integrated

2016

Table of Contents

Notes:

1. This is a companion document and instructors are to use the Arkansas K-12 Science Standards for Grades 5-8 document to guide curriculum development.
2. Student Performance Expectations (PEs) or standards may be taught in any sequence or grouping within a grade level. Several PEs are described as being "partially addressed in this course" because the same PE is revisited in a subsequent course during which that PE is fully addressed.
3. An asterisk (*) indicates an engineering connection to a practice, core idea, or crosscutting concept.
4. The clarification statements are examples and additional guidance for the instructor. AR indicates Arkansas-specific clarification statements.
5. The assessment boundaries delineate content that may be taught but not assessed in large-scale assessments. AR indicates Arkansas-specific assessment boundaries.
6. The examples given (e.g.,) are suggestions for the instructor.

Accelerated Science Course Pathway Overview

Arkansas Accelerated Science Course Pathway allows districts and schools an **option** to maximize opportunities for high-performing students to meet the Arkansas K-12 Science Standards as well as be prepared to pursue advanced level science courses earlier in middle and high school and at a more rapid pace. This accelerated science course pathway is not intended for all students, but for students who have demonstrated advanced academic proficiency in the prerequisite courses and who intend to pursue a specific college and career pathway beyond high school. Science is a quantitative discipline, so it is important for educators to ensure that students' science learning coheres well with their understanding of mathematics. To achieve this alignment, the Arkansas K-12 Science Committee made every effort to ensure that the mathematics standards do not outpace or misalign to the accelerated pathway courses. If this pathway is implemented, it is recommended that a unit of algebra I be earned concurrently with a unit of accelerated physical science-integrated, which requires a Grades 5-8 course approval for both the algebra I and the accelerated physical science-integrated course from the Arkansas Department of Education. Arkansas Accelerated Science Course Pathway details the following optional accelerated courses.

Accelerated Grade 6 Science	Course is an integration of 6th, 7th, and 8th Grade life science, Earth and space science, physical science, and engineering design standards.
Accelerated Grade 7 Science	Course is an integration of 6th, 7th, and 8th Grade life science, Earth and space science, physical science, and engineering design standards.
Accelerated Grade 8/Physical Science - Integrated	Course is an integration of the balance of 8th Grade physical science standards not mapped in the accelerated 6th and 7th Grade models and the high school physical science - integrated standards. *(5-8 course approval for physical science- integrated required)
Accelerated Biology - Integrated	Course is an integration of the biology - integrated standards with additional life science standards and clarification statements written by the Arkansas K-12 Science Committee.
Accelerated Chemistry - Integrated	Course is an integration of the chemistry - integrated course standards with additional chemistry standards and clarification statements written by the Arkansas K-12 Science Committee.

* A course approval for Grades 5-8 is necessary for a high school course to be taught at the middle school level. Teachers must hold the appropriate 7-12 licensure. Contact the ADE Curriculum Support Services unit for more details.

Accelerated Biology - Integrated Course Overview

Learning Progression Chart

Topic 1: Cycling of Matter and Energy	Topic 2: Structure and Function	Topic 3: Biodiversity and Population Dynamics	Topic 4: Genetic Variations in Organisms	Topic 5: Evolution by Natural Selection	Topic 6: Life and Earth's Systems	Topic 7: Human Impacts on Earth's Systems
ABI-LS1-5	AR ABI-LS1-1	ABI-LS2-1	AR ABI-LS1-4	AR ABI-LS4-1	ABI-ESS2-2	AR ABI-ESS3-1
ABI-LS1-7	AR ABI-LS1-2	ABI-LS2-2	ABI-LS3-1	ABI-LS4-2	ABI-ESS2-4	AR ABI-ESS3-2
AR ABI-LS2-3	AR ABI-LS1-3	AR ABI-LS2-6	ABI-LS3-2	ABI-LS4-3	ABI-ESS2-5	ABI-ESS3-3
ABI-LS2-4	AR ABI-LS1-6	AR ABI-LS2-7	ABI-LS3-3	ABI-LS4-4	ABI-ESS3-5	AR ABI-ESS3-4
ABI-LS2-5	ABI-LS2-1AR	ABI-LS2-8		AR ABI-LS4-5	AR ABI6-ETS1-2	AR ABI-ESS3-6
ABI-ESS2-6	ABI-LS2-2AR	AR ABI-LS4-6		ABI-LS4-7AR	AR ABI6-ETS1-3	AR AB7-ETS1-1
	ABI-LS2-3AR	AR ABI3-ETS1-3		ABI-LS4-8AR		AR AB7-ETS1-4
		AR ABI3-ETS1-4		AR ABI-ESS2-7		

Arkansas Clarification Statements/Assessment Boundaries (AR)

Arkansas Performance Expectation (AR)

Accelerated biology - integrated is a course composed of the biology – integrated course standards with additional life science standards and clarification/assessment boundary statements written by the Arkansas K-12 Science Committee.

The performance expectations in **Topic 1: Cycling of Matter** help students answer the question:

- How do matter and energy move through an ecosystem?

Students construct explanations, develop models, and use mathematical representations to demonstrate how the cycling of carbon-based molecules through photosynthesis and cellular respiration enables the flow of energy among organisms and within ecosystems. Students use quantitative models specifically to illustrate the role of photosynthesis and cellular respiration as two processes by which carbon is cycled among the biosphere, atmosphere, hydrosphere, and geosphere. Students use evidence to construct and revise an explanation of the role of aerobic and anaerobic respiration in different environments.

The performance expectations in **Topic 2: Structure and Function** help students answer the question:

- How do the structures of organisms enable living organisms to function?

Students model how a few elements combine to form complex biological molecules by dehydration synthesis. Students investigate explanations for the structure and function of cells as the basic units of life, the hierarchical systems of organisms, and the role of specialized cells for maintenance and growth. Students demonstrate understanding of how systems of cells function together to support the life processes by reading critically, using models, and conducting investigations. Students use a group of specific body systems to explain the interaction of systems in maintaining homeostasis. Students model a negative feedback loop to demonstrate understanding of homeostasis. Students explore various mechanisms of cell signaling and explain how a problem with cell signaling

can lead to disorder. Students perform various investigations with real and simulated cell membranes to demonstrate the structure of a selectively permeable membrane and transport mechanisms.

The performance expectations in **Topic 3: Biodiversity and Population Dynamics** help students answer the question:

- How do biotic and abiotic factors affect biodiversity?

Students investigate the role of biodiversity in ecosystems and the role of animal behavior on survival of individuals and species. Students analyze organisms' interactions with each other and their physical environment including symbiotic relationships, how organisms change the environment, and how these changes affect both organisms and the environment. Students use evidence to explain those interactions and changes. Students explore solutions for major global problems, evaluate possible solutions for reducing the impact of human activities on biodiversity, and use computer simulations to model and test those solutions, considering a wide range of criteria including cost-benefit analysis.

The performance expectations in **Topic 4: Genetic Variations in Organisms** help students answer these questions:

- How are the characteristics of one generation related to previous and future generations?

- How does genetic variation contribute to biodiversity?

Students explain the relationship of DNA and chromosomes to cellular division, protein synthesis, and mutations. Students investigate mitosis within the cell cycle including the control mechanisms and the events occurring within interphase including DNA replication. Students analyze the mechanisms of inheritance and gene expression, as well as environmental and genetic causes of gene mutations. Students formulate questions and construct arguments about ethical issues related to the genetic modification of organisms. Students develop conceptual models for the role of DNA in the unity of life on earth and use statistical models to explain the importance of variation within population for the survival and evolution of species.

The performance expectations in **Topic 5: Evolution by Natural Selection** help students answer these questions:

- How can very different organisms also have so many similarities?

- What causes species to change over time?

Students investigate the claim that eukaryotic cells evolved from prokaryotic cells by making a comparison of the structure of prokaryotic and eukaryotic cells with an emphasis on compartmentalization and complexity as outlined in the theory of endosymbiosis. Students investigate patterns to find relationships between environmental conditions and natural selection, highlighting factors that drive the evolution or extinction of species over time. Students utilize statistics and probability to investigate the distribution of genes and traits in a population over time, demonstrating how natural selection leads to the adaptation of populations. Students analyze scientific evidence ranging from the fossil record to genetic relationships to evaluate how multiple lines of evidence support the scientific theories of natural selection and evolution. Students use a cladogram or phylogenetic tree to model proposed evolutionary relationships.

The performance expectations in **Topic 6: Life and Earth's Systems** help students answer these questions:

- How does life influence Earth's systems?

- How do Earth's systems influence life?

Students investigate the interrelationships between biotic and abiotic factors that contribute to changes in Earth's dynamic systems. Students examine how Earth's systems may appear stable, change slowly over long periods of

time, or change abruptly, with significant consequences for living organisms. Students develop models and analyze data to explain and forecast changes to Earth's various climates. Students examine how climate change can occur when certain parts of Earth's systems are altered and predict how living organisms may affect and be affected. Students study the relationship of blue-green algae and oxygen concentration in the atmosphere; then, investigate how the rate of fresh water intrusion from melting polar ice affects the growth of the blue-green algae. Students model the structure of the water molecule and explain how the structure and properties of water are essential to the moderation of climate. Students use both qualitative and quantitative data to support their analysis and conclusion.

The performance expectations in **Topic 7: Human Impacts on Earth's Systems** help students answer these questions:

- How have Earth's systems affected human populations and human activities?

- How do human activities impact Earth's systems?

Students examine the complex interdependence between humans and their environment by simulating specific relationships between natural resources, natural hazards, climate, biodiversity, and the sustainability of human populations. Students research sustainability practices that promote the conservation of natural resources. Students analyze geoscience models to highlight the interactions between Earth's various systems, forecast future rates of global or regional climate change, and predict the resulting impacts on the environment. Students utilize science and engineering practices to evaluate and refine solutions that reduce human impacts on natural systems, managing natural resources, protecting biodiversity, and maintaining healthy ecosystems. Students analyze current regional or global issues, such as the spread of viruses and their impact on health, the economy and society. Students use both qualitative and quantitative data to support their analysis and conclusion.

Additionally, it should be noted that the accelerated biology - integrated standards are not intended to be used as curriculum. Instead, the standards are the minimum that students should know and be able to do. Therefore, teachers should continue to differentiate for the needs of their students by adding depth and additional rigor.

Students in accelerated biology - integrated also continue their ability to develop possible solutions for major global problems with engineering design challenges. At the high school level, students are expected to engage with major global issues at the interface of science, technology, society and the environment, and to bring to bear the kinds of analytical and strategic thinking that prior training and increased maturity make possible. As in prior levels, these capabilities can be thought of in three stages—defining the problem, developing possible solutions, and improving designs:

● **Defining the problem** at the high school level requires both qualitative and quantitative analysis. For example, the need to provide food and fresh water for future generations comes into sharp focus when considering the speed at which the world population is growing, and conditions in countries that have experienced famine. While high school students are not expected to solve these challenges, they are expected to begin thinking about them as problems that can be addressed, at least in part, through engineering.

● **Developing possible solutions** for major global problems begins by breaking them down into smaller problems that can be tackled with engineering methods. To evaluate potential solutions students are expected to not only consider a wide range of criteria, but to also recognize that criteria need to be prioritized. For example, public safety or environmental protection may be more important than cost or even functionality. Decisions on priorities can then guide tradeoff choices.

● **Improving designs** at the high school level may involve sophisticated methods, such as using computer simulations to model proposed solutions. Students are expected to use such methods to take into account a range of criteria and constraints, to try and anticipate possible societal and environmental impacts, and to test the validity of their simulations by comparison to the real world.

Accelerated Biology - Integrated

Topic 1: Cycling of Matter and Energy	
ABI-LS1-5	**Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.** [Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] [Assessment Boundary: Assessment does not include specific biochemical steps.]
ABI-LS1-7	**Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.** [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.]
ABI-LS2-3	**Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.** [AR Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments. Explanation should include glycolysis and the processes within the mitochondria.]
ABI-LS2-4	**Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]
ABI-LS2-5	**Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.** [Clarification Statement: Examples of models could include simulations and mathematical models.] [Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.]
ABI-ESS2-6	**Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.** [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]
The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Biology - Integrated.	

Accelerated Biology - Integrated

Topic 2: Structure and Function

Students who demonstrate understanding can:

ABI-LS1-1   **Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.** [AR Clarification Statement: A model of the process of protein synthesis may be needed to support the explanation of the formation of proteins including enzymes.] [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.]

ABI-LS1-2   **Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.** [AR Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. This could include all types of multicellular organisms. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system]. [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]

ABI-LS1-3   **Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.** [AR Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.]

ABI-LS1-6   **Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.** [AR Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations for the formation of polymers from monomers including carbohydrates, lipids, nucleic acids and proteins (enzymes).]

ABI-LS2-1AR   **Develop and use a model to explain a negative feedback loop.** [AR Clarification Statement: Examples of negative feedback loops could include regulation of blood sugar, blood pressure, body temperature, and transpiration in plants.]

ABI-LS2-2AR   **Develop and use a model to demonstrate the mechanism of cell signaling as a basis of control for cell activities.** [AR Clarification Statement: Examples of cell signaling mechanisms could include hormones, neurotransmitters, antigen/antibody interactions. Dysfunction within cell signaling mechanisms can lead to disorders (e.g., cancer or diabetes).]

ABI-LS12-3AR   **Plan and conduct an investigation to determine the relationship between the structure of a plasma membrane and its function.** [AR Clarification Statement: Focus is on transport mechanisms, such as diffusion, osmosis, endocytosis, exocytosis, phagocytosis and pinocytosis.]

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Accelerated Biology - Integrated

Topic 3: Biodiversity and Population Dynamics

Students who demonstrate understanding can:

ABI-LS2-1   **Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.** [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.]

ABI-LS2-2   **Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]

ABI-LS2-6   **Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.** [AR Clarification Statement: Examples of changes in ecosystem conditions could result from modest biological or physical changes, such as moderate hunting or a seasonal flood or community interactions such as symbiotic relationships. Examples of extreme changes could include events such as volcanic eruption or sea level rise.]

ABI-LS2-7   **Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*** [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on the impact of human activities on biodiversity such as dissemination of invasive species, habitat degradation, and water quality.] [AR Assessment Boundary: Assessment is to include student choice from multiple scenarios.]

ABI-LS2-8   **Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.** [Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]

ABI-LS4-6   **Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*** [AR Clarification Statement: Emphasis is on refining solutions for a proposed problem related to threatened or endangered species, genetic variation of organisms for multiple species, and biodiversity.]

ABI3-ETS1-3   **Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.** [AR Clarification Statement: Problems could include effect of logging on animal or human populations, response to invasive species, agricultural practices, creating dams, and maintaining fish populations in public lakes.]

ABI3-ETS1-4   **Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.** [AR Clarification Statement: Could include simulations of population dynamics, genetic drift, evolution, and migration.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Biology - Integrated.

Accelerated Biology - Integrated

Topic 4: Genetic Variations in Organisms
Students who demonstrate understanding can:
ABI-LS1-4 **Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.** [AR Clarification Statement: Emphasis on the role of mitosis within the cell cycle including the control mechanisms and the events occurring within interphase including DNA replication.]
ABI-LS3-1 **Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.** [AR Assessment Boundary: Assessment does include the phases of meiosis or the biochemical mechanism of specific steps in the process.]
ABI-LS3-2 **Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.** [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]
ABI-LS3-3 **Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.** [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.]
The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Biology - Integrated.

Topic 5: Evolution by Natural Selection

ABI-LS4-1   **Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.** [AR Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development. Sources for information may include cladograms and /or phylogenetic trees.]

ABI-LS4-2   **Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.** [Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]

ABI-LS4-3   **Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.** [Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.] [Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.]

ABI-LS4-4   **Construct an explanation based on evidence for how natural selection leads to adaptation of populations.** [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]

ABI-LS4-5   **Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.** [AR Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, overfishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]

ABI-LS4-7AR   **Obtain, evaluate, and communicate the claim that eukaryotic cells evolved from prokaryotic cells.** [AR Clarification Statement: Evidence may include a comparison of the structure of prokaryotic and eukaryotic cells with an emphasis on compartmentalization and complexity as outlined in the theory of endosymbiosis.]

ABI-LS4-8AR   **Evaluate evidence to support the claim that viruses are subject to mutations and may have a positive, negative, or neutral impact on a species, including humans.** [AR Clarification: Emphasis is on that viruses may contain DNA or RNA and require a host cell to replicate.]

ABI-ESS2-7   **Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.** [AR Clarification Statement: This PE is fully addressed in this course. Emphasis in the course is on developing a claim and evaluating and critiquing the evidence for simultaneous co-evolution. Emphasis is on the causes, effects, and feedback loops between the biosphere and Earth's other systems which continuously alters Earth's surface. Examples could include how photosynthetic life altered the atmosphere through the production of oxygen, which increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil which allowed for the evolution of land plants; and how the evolution of corals created reefs which altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of life forms.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Biology - Integrated.

Topic 6: Life and Earth's Systems

Students who demonstrate understanding can:

ABI-ESS2-2 **Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.** [Clarification Statement: Examples could include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]

ABI-ESS2-4 **Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.** [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]

ABI-ESS2-5 **Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.** [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on the properties of water including, heat capacity, density of water in its solid and liquid states, and polar nature of the water molecule and how these properties of water affect Earth materials for example: stream transportation and deposition, erosion, expansion of water as it freezes.]

ABI-ESS3-5 **Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.** [AR Clarification Statement: Examples of evidence (precipitation and temperature) for both data and climate models and their associated impacts (sea level changes, glacial ice volumes, and atmosphere and ocean composition) could be found at National Oceanic and Atmospheric Administration, National Weather Service, and United States Geological Survey.] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]

ABI6-ETS1-2 **Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.** [AR Clarification Statement: Proposed problems could include increases in pollution, greenhouse gases, water runoff and soil erosion, coastal erosion, and loss of wetlands.]

ABI6-ETS1-3 **Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.** [AR Clarification Statement: The solutions could be designed by students or identified from scientific studies.]

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Accelerated Biology - Integrated

Topic 7: Human Impacts on Earth's Systems

Students who demonstrate understanding can:

ABI-ESS3-1 **Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on the way climate change has impacted human populations and how natural resources and natural hazards impact human societies. Examples of climate change results which affect populations or drive mass migrations could include changes to sea level, regional patterns of temperature and precipitation, and types of crops and livestock available. Examples of the dependence of human populations on technology to acquire natural resources and to avoid natural hazards could include damming rivers, natural gas fracking, thunderstorm sirens, and severe weather text alerts.]

ABI-ESS3-2 **Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*** [AR Clarification Statement: This PE is fully addressed in this course. Emphasis in this course is on the designs of possible solutions. Emphasis is on the conservation, recycling, and reuse of resources (minerals and metals), and on minimizing impacts. Examples could include developing best practices for agricultural soil use, mining (coal, tar sands, and oil shales), and pumping (petroleum and natural gas).]

ABI-ESS3-3 **Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]

ABI-ESS3-4 **Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*** [AR Clarification Statement: This PE is partially addressed in this course. Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, and changes in land surface (urban development, agriculture or livestock, and surface mining). Examples for limiting future impacts could range from local efforts (reducing, reusing, and recycling resources) to large-scale bioengineering design solutions (altering global temperatures by making large changes to the atmosphere or ocean).]

ABI-ESS3-6 **Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.** [AR Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and biosphere. Examples of far-reaching impacts related to human activity, include how increases in one or more atmospheric gasses (CO_x, NO_x, SO_x, and volatile organic compounds), and particulate matter could impact other Earth systems. For example, an increase in carbon dioxide results in an increase in photosynthetic biomass and ocean acidification with resulting impacts on marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

ABI7-ETS1-1 **Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.** [AR Clarification Statement: Examples could include recycling, increased atmospheric carbon dioxide, ocean acidification, impacts on marine populations, increased wildfire occurrence, deforestation, and overfishing.]

ABI7-ETS1-4 **Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.** [AR Clarification Statement: Simulations could include management of natural resources for sustainable yields, agricultural efficiency to feed a growing world population, and urban planning to maximize green space.]

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for Biology - Integrated.