INDIANA DEPARTMENT *of* EDUCATION

2024 INDIANA CONTENT CONNECTORS

SCIENCE

BIOLOGY

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Indiana Content Connectors Context and Purpose

Introduction

The Indiana Content Connectors for Biology are the result of a process designed to identify, evaluate, synthesize, and create high-quality learning expectations for Indiana students with significant cognitive disabilities.

The Indiana Department of Education (IDOE) convened stakeholder committees to review proposed revisions to Indiana's Alternative Standards, known as content connectors. The content connectors are designed to measure the knowledge and skills of students with the most significant cognitive disabilities and are assessed with the state's alternate assessment. The content connectors are designed to ensure that all Indiana students in this population are prepared with essential knowledge and skills needed to access employment, enrollment, or enlistment leading to service.

What are the Content Connectors and how should they be used?

The Indiana Content Connectors are designed to help educators, parents, students, and community members understand the necessary content for each grade level, and within each content area domain, to access employment, enrollment, or enlistment leading to service. These content connectors should form the basis for strong core instruction for all students at each grade level and content area. The content connectors identify the minimum academic content or skills to which Indiana students need access in order to be prepared for success after graduation, but they are not an exhaustive list.

While the Indiana Content Connectors establish key expectations for knowledge and skills and should be used as the basis for curriculum, the content connectors by themselves do not constitute a curriculum. It is the responsibility of the local school corporation to select and formally adopt curricular tools, including textbooks and any other supplementary materials, that align with Indiana Content Connectors. Additionally, corporation and school leaders should consider the appropriate instructional sequence of the content connectors as well as the length of time needed to teach each one. Every content connector has a unique place in the continuum of learning, but each content connector will not require the same amount of time and attention. A deep understanding of the vertical articulation of the standards will enable educators to make the best instructional decisions. These content connectors must also be complemented by robust, evidence-based instructional practices to support overall student development. By utilizing strategic and intentional instructional practices, other areas such as STEM and employability skills can be integrated with the content connectors.

Acknowledgments

IDOE appreciates the time, dedication, and expertise offered by Indiana's K-12 general and special educators, higher education professors, representatives from business and industry, families, and other stakeholders who contributed to the development of the Indiana Content Connectors. We wish to specially acknowledge the committee members, as well as participants in the public comment period, who dedicated many hours to the review and evaluation of these content connectors designed to prepare Indiana students for success after graduation.

Biology

Standards and content connectors identified as essential for mastery by the end of the course are indicated with gray shading and an "E."

Indiana Academic Standards	Content Connectors
From Molecules to Organisms: Structures and Processes	
HS-LS1-1: From Molecules to Organisms: Structures and Processes Students who demonstrate understanding can: 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. [Clarification Statement: Emphasis is on how the structure of regions of DNA, called genes, determine the structure of proteins. Proteins are made and carry out the essential functions of life within different cellular organelles. Examples of essential proteins can include enzymes, membrane channels, immune proteins.] (E)	**HS-LS1-1a:** Match different cell types to the specific functions they perform. (E) **HS-LS1-1b:** Identify evidence to support an explanation of the relationship among DNA and genes in making the different proteins needed for cells to function. (E)
HS-LS1-2: From Molecules to Organisms: Structures and Processes Students who demonstrate understanding can: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [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. 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.]	**HS-LS1-2a:** Use a model to identify a part of a multicellular organism and the process it performs. **HS-LS1-2b:** Identify the components in a model of interacting hierarchical systems that perform specific functions within multicellular organisms.

HS-LS1-3: From Molecules to Organisms: Structures and Processes Students who demonstrate understanding can: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. [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.]	**HS-LS1-3a:** Conduct an investigation and use evidence to describe how positive and negative feedback mechanisms maintain homeostasis.
HS-LS1-4: From Molecules to Organisms: Structures and Processes Students who demonstrate understanding can: Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (E)	**HS-LS1-4a:** Given a model, describe that cellular division (mitosis) and/or differentiation leads to producing and/or maintaining complex organisms. (E)
HS-LS1-5: From Molecules to Organisms: Structures and Processes Students who demonstrate understanding can: 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.]	**HS-LS1-5a:** Use a model to describe how photosynthesis results in the transformation of light energy to stored chemical energy. (E)

HS-LS1-6: From Molecules to Organisms: Structures and Processes Students who demonstrate understanding can: 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. [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] (E)	**HS-LS1-6a:** Use evidence or a model to show that organisms take in matter and rearrange elements and molecules for growth and/or maintenance of large carbon-based molecules. (E)
HS-LS1-7: From Molecules to Organisms: Structures and Processes Students who demonstrate understanding can: 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.]	**HS-LS1-7a:** Use a model to illustrate the chemical processes in cellular respiration.
Ecosystems: Interactions, Energy, and Dynamics	
HS-LS2-1: Ecosystems: Interactions, Energy, and Dynamics Students who demonstrate understanding can: 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.]	**HS-LS2-1a:** Use a graphical representation to explain changes in the population size of an animal species over time.
	HS-LS2-1b: Connect the limits of an ecosystem's carrying capacity (the number of organisms it can support) to the availability of living and nonliving resources and other challenges (e.g., predation, competition, disease).

HS-LS2-2: Ecosystems: Interactions, Energy, and Dynamics Students who demonstrate understanding can: 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.]	**HS-LS2-2a:** Use mathematical representations (e.g., trends, averages, graphs) to support how biodiversity is dependent on the resources available in its ecosystem.
	HS-LS2-2b: Explain the expected effect on the number and/or types of organisms in an ecosystem given a modest versus an extreme change/disturbance.
HS-LS2-3: Ecosystems: Interactions, Energy, and Dynamics Students who demonstrate understanding can: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. [Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.] (E)	**HS-LS2-3a:** Use evidence to explain that energy is the driving force in the cycling of matter in aerobic or anaerobic conditions. (E)
HS-LS2-4: Ecosystems: Interactions, Energy, and Dynamics Students who demonstrate understanding can: 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.]	**HS-LS2-4a:** Identify the changes in the amount of matter (biomass) as it travels through a food web.
	HS-LS2-4b: Identify the changes in the amount of energy as it travels through an ecosystem using a model (e.g., energy pyramid, food chains, food webs, and biomass pyramids).
HS-LS2-5: Ecosystems: Interactions, Energy, and Dynamics Students who demonstrate understanding can: 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.]	**HS-LS2-5a:** Illustrate the path of carbon as it is exchanged between living and nonliving systems (biosphere, atmosphere, hydrosphere, geosphere) using a model.(E)
	HS-LS2-5b: Identify relevant components (i.e., inputs and outputs of photosynthesis; inputs and outputs of cellular respiration) of a model

	of the exchange of carbon between organisms and the environment.
HS-LS2-6: Ecosystems: Interactions, Energy, and Dynamics Students who demonstrate understanding can: 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. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]	**HS-LS2-6a:** Explain how living things in an ecosystem are affected by changes in the environment based on provided data. **HS-LS2-6b:** Support or refute a claim regarding how a modest change versus an extreme change will affect stability of an ecosystem using evidence.
HS-LS2-7: Ecosystems: Interactions, Energy, and Dynamics Students who demonstrate understanding can: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.] (E)	**HS-LS2-7a:** Describe how human activity affects Earth's environment and biodiversity and how people can help reduce their impact. [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.] (E)
HS-LS2-8: Ecosystems: Interactions, Energy, and Dynamics Students who demonstrate understanding can: 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.]	**HS-LS2-8a:** Identify evidence supporting the outcome of group (flocking, schooling, herding) or cooperative (hunting, migrating, and swarming) behavior on species' chances to survive and reproduce.

Heredity: Inheritance and Variation of Traits

HS-LS3-1: Heredity: Inheritance and Variation of Traits Students who demonstrate understanding can: Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. (E)	**HS-LS3-1a:** Explain that DNA molecules in all cells contain the instructions (genes) for traits passed from parents to offspring.
HS-LS3-2: Heredity: Inheritance and Variation of Traits Students who demonstrate understanding can: 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.] (E)	**HS-LS3-2a:** Use evidence to defend a claim that parents and offspring may have different traits as a result of genetic combinations, errors during replication, or mutations caused by environmental factors. **HS-LS3-2b:** Classify examples of variations of traits in a population (mutations in DNA) caused by new genetic combinations (meiosis), errors during replication, and/or mutations caused by environmental factors.
HS-LS3-3: Heredity: Inheritance and Variation of Traits Students who demonstrate understanding can: 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.]	**HS-LS3-3a:** Calculate the probability of a particular trait in an offspring or the occurrence of a variation in a population.
Biological Evolution: Unity and Diversity	
HS-LS4-1: Biological Evolution: Unity and Diversity Students who demonstrate understanding can: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. [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,	**HS-LS4-1a:** Identify patterns of (homologous) structures (e.g., fossil records, DNA sequences, amino acid sequences, anatomical and embryological evidence) as evidence to a claim of common ancestry and biological evolution.

and order of appearance of structures in embryological development.]	
HS-LS4-2: Biological Evolution: Unity and Diversity Students who demonstrate understanding can: 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 the 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.] (E)	**HS-LS4-2a:** Identify evidence that biological evolution results from (1) potential for a species to increase in number, (2) heritable genetic variation of individuals in a species, (3) competition for limited resources, and (4) organisms with advantageous traits are better able to survive and reproduce in the environment. (E)
HS-LS4-3: Biological Evolution: Unity and Diversity Students who demonstrate understanding can: 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.]	**HS-LS4-3a:** Use data to explain how organisms' traits that allow them to survive better in a specific environment are more common in the population. **HS-LS4-3b:** Use calculations to explain how the population of organisms with advantageous heritable traits will increase over time to organisms without these traits.

HS-LS4-4: Biological Evolution: Unity and Diversity Students who demonstrate understanding can: 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.]	**HS-LS4-4a:** Explain the cause-and-effect relationship between natural selection due to specific biotic and abiotic differences in ecosystems (e.g., ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, evolution of other organisms) that leads to an increasing proportion of individuals within a population with advantageous characteristics (adaptation).
HS-LS4-5: Biological Evolution: Unity and Diversity Students who demonstrate understanding can: 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. [Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]	**HS-LS4-5a:** Use evidence to describe the cause-and-effect relationship of changes in the environment to the emergence of a new species or changes in the number, survival, or extinction of some species.
HS-LS4-6: Biological Evolution: Unity and Diversity Students who demonstrate understanding can: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. [Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]	**HS-LS4-6a:** Generate a solution addressing adaptation to reduce the effects of a human activity that decreases biodiversity. **HS-LS4-6b:** Determine which human actions help versus harm a threatened or endangered species.