Indiana Academic Standards
Science

Anatomy and Physiology

K-12 Science Indiana Academic Standards Overview

The K-12 Science Indiana Academic Standards are based on *A Framework for K-12 Science Education* (NRC, 2012) and the Next Generation Science Standards (NGSS Lead States, 2013). They are meant to reflect a new vision for science education. The following conceptual shifts reflect what is new about these science standards. The K-12 Science Indiana Academic Standards:

- Reflect science as it is practiced and experienced in the real world;
- Build logically from kindergarten through grade 12;
- Focus on deeper understanding as well as application of content; and
- Integrate practices, crosscutting concepts, and core ideas.

The K-12 Science Indiana Academic Standards outline the knowledge, science, and engineering practices that all students should learn by the end of high school. The standards are three-dimensional because each student performance expectation engages students at the nexus of the following three dimensions:

- Dimension 1 describes scientific and engineering practices.
- Dimension 2 describes crosscutting concepts, overarching science concepts that apply across science disciplines.
- Dimension 3 describes core ideas in the science disciplines.

Science and Engineering Practices (*as found in NGSS*)

The eight practices describe what scientists use to investigate and build models and theories of the world around them or that engineers use as they build and design systems. The practices are essential for all students to learn and are as follows:

1. Asking questions (for science) and defining problems (for engineering);
2. Developing and using models;
3. Planning and carrying out investigations;
4. Analyzing and interpreting data;
5. Using mathematics and computational thinking;
6. Constructing explanations for science and designing solutions for engineering;
7. Engaging in argument from evidence; and
8. Obtaining, evaluating, and communicating information.

Crosscutting Concepts (*as found in NGSS*)

The seven crosscutting concepts bridge disciplinary boundaries and unit core ideas throughout the fields of science and engineering. Their purpose is to help students deepen their understanding of the disciplinary core ideas, and develop a coherent, and scientifically based view of the world. The seven crosscutting concepts are as follows:

1. *Patterns.* Observed patterns of forms and events guide organization and classification, and prompt questions about relationships and the factors that influence them.
2. *Cause and Effect: Mechanism and Explanation*. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated.

Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

3. *Scale, Proportion, and Quantity.* In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
4. *Systems and System Models.* Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
5. *Energy and Matter: Flows, Cycles, and Conservation.* Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
6. *Structure and Function.* The way in which an object or living thing is shaped and its substructure determines many of its properties and functions.
7. *Stability and Change.* For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Disciplinary Core Ideas (*as found in NGSS*)

The disciplinary core ideas describe the content that occurs at each grade or course. The K-12 Science Indiana Academic Standards focus on a limited number of core ideas in science and engineering both within and across the disciplines and are built on the notion of learning as a developmental progression. The Disciplinary Core Ideas are grouped into the following domains:

- Physical Science (PS)
- Life Science (LS)
- Earth and Space Science (ESS)
- Engineering, Technology and Applications of Science (ETS)

The K-12 Science Indiana Academic 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.

References:

- National Research Council. 2012. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. https://doi.org/10.17226/13165.
- NGSS Lead States. 2013. *Next Generation Science Standards: For States, By State*s. Washington, DC: The National Academies Press.

How to read the revised Science Indiana Academic Standards

Standard Number **Title** The title for a set of performance expectations is not necessarily unique and may be reused at several different grade levels.

Students who demonstrate understanding can:

Standard Number **Performance Expectation: A statement that combines practices, core ideas, and crosscutting concepts together to describe how students can show what they have learned.** [Clarification Statement: A statement that supplies examples or additional clarification to the performance expectation.]

Science and Engineering Practices

Science and Engineering Practices are activities that scientists and engineers engage in to either understand the world or solve the problem.

There are 8 practices. These are integrated into each standard. They were previously found at the beginning of each grade level content standard and known as SEPs.

Connections to the Nature of Science

Connections are listed in either practices or the crosscutting concepts section.

Disciplinary Core Ideas

Disciplinary Core Ideas are concepts in science and engineering that have broad importance within and across disciplines as well as relevance in people's lives.

To be considered core, the ideas should meet at least two of the following criteria and ideally all four:

- Have broad importance across multiple sciences or engineering disciplines or be a key organizing concept of a single discipline.
- Provide a key tool for understanding or investigating more complex ideas and solving problems.
- Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledge.
- Be teachable and learnable over multiple grades at increasing levels of depth and sophistication.

Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology, and applications of science.

Crosscutting Concepts

Crosscutting concepts are seven ideas such as Patterns and Cause and Effect, which are not specific to any one discipline but cut across them all.

Crosscutting concepts have value because they provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas.

Connections to Engineering, Technology and Applications of Science

These connections are drawn from either the Disciplinary Core Ideas or Science and Engineering Practices.

Standard AP1: Levels of Organization in the Human Body

Students who demonstrate understanding can

HS-AP1-1.* **Plan and conduct and investigation to provide evidence that feedback mechanisms maintain homeostasis in humans.**

HS-AP1-2.* **Develop and use a model to illustrate the hierarchical organization of structural body systems that provide specific functions within the Human Body.**

HS-AP1-3.* **Compare and contrast the relationships among the various tissue types as well as the molecular and cellular composition of these tissues.**

HS-AP1-4.* **Compare and contrast the histological structure between the 4 basic tissue types.**

HS-AP1-5.* **Compare and contrast the major organ systems and describe their basic functional importance.**

HS-AP1-6.* **Identify anatomical terms (including anatomical orientation, regions, planes) on a diagram, model, or through dissection.**

Science and Engineering Practices

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SEP.2: Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

Disciplinary Core Ideas

LS1.A: Structure and Function

- Systems of specialized cells within organisms help them perform the essential functions of life.
- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. *(Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)*

Crosscutting Concepts

CC.6: Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

*Denotes Indiana Specific Standard

Standard AP2: Movement and Support, the Integumentary System

Students who demonstrate understanding can:

HS-AP2-1.* **Analyze the structural characteristics and functional importance of the integumentary system to maintain homeostasis of the body.**

HS-AP2-2.* **Evaluate and explain the consequence of injury (e.g., Burns) and/or disease (e.g., skin cancer, vitiligo) to the functionality of the integumentary system.**

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Standard AP3: Movement and Support, the Skeletal System

Students who demonstrate understanding can:

HS-AP3-1.* **Develop a model to illustrate the microscopic structure, development of, maintenance of, and function of compact and spongy bone.**

HS-AP3-2.* **Observe the characteristics of a bone from the axial or appendicular skeleton. Then construct an argument to support how the structure determines the function**

HS-AP3-3.* **Locate and identify individual bones of the axial and appendicular skeleton and unique features of bones.**

HS-AP3-4.* **Compare and contrast the different types of bone (e.g., long, short, flat, and irregular.**

HS-AP3-5.* **Compare and contrast the major types of joints and construct an argument how these structural components influence functional mobility and stability.**

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Standard AP4: Movement and Support, the Muscular System

Students who demonstrate understanding can:

HS-AP4-1.* **Compare and contrast between the structural and functional characteristics of skeletal, cardiac, and smooth muscle.**

HS-AP4-2.* **Develop a model to illustrate the components of a muscle fiber and how they interact in contraction and relaxation.**

HS-AP4-3.* **Conduct an investigation to analyze the molecular processes involved in sliding filament models to explain and identify changes in disease-related illnesses.**

HS-AP4-4.* **Describe how a neuromuscular junction functions. Design an experiment to determine how motor recruitment influences the force and velocity of contraction.**

HS-AP4-5.* **Use a diagram, model, or dissection to identify major muscle groups.**

HS-AP4-6.* **Compare and contrast between isotonic and isometric contractions and construct an explanation for the causes of hypertrophy and atrophy of muscles.**

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CC.2: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Standard AP5: Integration and Coordination, the Nervous System

Students who demonstrate understanding can:

HS-AP5-1.* **Develop a model that illustrates the structural components and functional subdivisions of the nervous system.**

HS-AP5-2.* **Observe and identify the structure and function of the various neurons and neuroglia. Explain how the varying structures determine the specified function.**

HS-AP5-3.* **Compare and contrast the actions, origins, and pathways of nerve fibers in the parasympathetic and sympathetic divisions of the autonomic nervous system.**

HS-AP5-4.* **Identify and model how action potentials are generated, via neurotransmitters, the ions and channel protein involved, and the basic structural and functional aspects which allow for synaptic connection.**

HS-AP5-5.* **Identify the various classification of neurotransmitters and their associated functions.**

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Standard AP6: Integration and Coordination, Somatic and Special Senses

Students who demonstrate understanding can:

HS-AP6-1.* **Compare and contrast the somatic, visceral, and special senses, the prominent sensory receptor types of each, and their functional operation.**

HS-AP6-2.* **Make and/or use a model of the anatomy of the eye; then construct an explanation for hyperopia, myopia and astigmatism using the model.**

HS-AP6-3.* **Make and/or use a model of the anatomy of the ear. Construct an explanation for sensorineural and conductive hearing loss using the basic structure and function of the ear.**

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Standard AP7: Integration and Coordination, the Endocrine System

Students who demonstrate understanding can:

HS-AP7-1.* **Investigate the structure and function of the endocrine system and develop models showing how changes in prominent hormone levels impact homeostasis throughout the body systems.**

HS-AP7-2.* **Assess the structural and functional differences between an endocrine gland and an exocrine gland.**

HS-AP7-3.* **Compare and contrast the hormones of the hypothalamus-pituitary complex. Analyze the function of each hormone and connect them to feedback signals for the gonads, thyroid, and adrenal cortex.**

HS-AP7-4.* **Construct an explanation to show the impact of stress on the hypothalamus-pituitary complex, sympathetic nervous system, and the adrenal medulla.**

HS-AP7-5.* **Construct an explanation for maintaining blood sugar levels via endocrine and exocrine functions of the pancreas.**

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Standard AP8: Transport, Blood and the Cardiovascular System

Students who demonstrate understanding can:

HS-AP8-1.* **Perform an investigation to identify the composition and function of whole blood components, and the role they play in maintaining homeostasis.**

HS-AP8-2.* **Conduct an investigation to learn about the ABO blood type. Discuss how the surface-antigens and plasma antibodies allow and/or disallow for certain blood transfusions.**

HS-AP8-3.* **Investigate the primary structures of the cardiovascular system and explore their functional importance to maintaining homeostasis.**

HS-AP8-4.* **Create a model of vasoconstriction and vasodilation to demonstrate the structural and functional difference between arteries and veins.**

HS-AP8-5.* **Use a diagram and/or a model of the heart to illustrate the external and internal structures, the vessels entering and exiting, unidirectional blood flow and how the heart supports pulmonary and cardiac circulation.**

HS-AP8-6.* **Construct a model of hypertension to model the regulation of the cardiac cycle.**

HS-AP8-7.* **Design an experiment to illustrate how the cardiovascular system maintains homeostasis.**

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Standard AP9: Transport, the Lymphatic System and Immune Mechanisms

Students who demonstrate understanding can:

HS-AP9-1.* **Identify the primary structural and functional components of the lymphatic system.**

HS-AP9-2.* **Analyze the relationship of the components of the lymphatic system with bone marrow and the thymus gland.**

HS-AP9-3.* **Differentiate between innate and acquired immunity.**

HS-AP9-4.* **Construct an explanation for defense against foreign pathogens using cellular and non-cellular components of the immune response.**

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Standard AP10: Absorption and Excretion, the Digestive System

Students who demonstrate understanding can:

HS-AP10-1.* **Identify and locate major and accessory organs of the digestive system and investigate their physiological functions.**

HS-AP10-2.* **Construct an explanation for enzymes involved in the processing of, digestion of and absorbance of macromolecules.**

HS-AP10-3.* **Compare and contrast mechanical and chemical digestion.**

HS-AP10-4.* **Differentiate between metabolic and respiratory acidosis and alkalosis.**

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Standard AP11: Absorption and Excretion, the Respiratory System

Students who demonstrate understanding can:

HS-AP11-1.* **Identify and locate major organs of the respiratory system and discuss their functions. Differentiate between the components of the upper and lower respiratory systems.**

HS-AP11-2.* **Observe the anatomical structures and explain the physiological processes involved in inspiration & expiration.**

HS-AP11-3.* **Analyze data to investigate how percentages and partial pressure gradients of oxygen and carbon dioxide impact net gas exchange.**

HS-AP11-4.* **Construct an explanation for maintaining blood pH via specialized carbon dioxide receptors and the respiratory response.**

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Standard AP12: Absorption and Excretion, the Urinary System

Students who demonstrate understanding can:

HS-AP12-1.* **Identify and locate major organs of the urinary system and discuss their functions.**

HS-AP12-2.* **Observe and identify the structures of the kidney; then construct an explanation for maintaining blood volume via kidney function.**

HS-AP12-3.* **Develop a model of the nephron to explore its structural components, associated hormones, and the functional processes of filtration, excretion, secretion, and reabsorption.**

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- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. *(Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)*

Crosscutting Concepts

CC.6: Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

CC.2: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Standard AP13: Life Cycle, the Reproductive System

Students who demonstrate understanding can:

HS-AP13-1.* **Identify and locate major and accessory organs of the female and male reproductive systems and discuss their functions.**

HS-AP13-2.* **Create a diagram or model to analyze the role of hormones in the male and female reproductive system.**

HS-AP13-3.* **Describe how spermatozoa move through the female reproductive tract and describe the process of fertilization.**

HS-AP13-4.* **Construct an explanation of the rise of the three primary germ layers via zygote creation, blastocyst development and gastrulation process.**

HS-PS13-5.* **Describe the stages of embryonic development after gastrulation, up to the birth of a baby.**

Science and Engineering Practices

SEP.3: Planning and Carrying Out Investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

SEP.2: Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

Disciplinary Core Ideas

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