

Introduction to Indiana's Academic Standards for Science – 2010

Indiana's Academic Standards for Science were last revised in 2000. This new document, Indiana's Academic Standards for Science – 2010, reflects the ever-changing science content and the underlying premise that science education should be an inquiry-based, hands-on experience. These standards were adopted by the Indiana State Board of Education in April, 2010, and will be implemented in the 2011-12 school year.

Indiana's Academic Standards for Science – 2010 reflect a few significant changes that are worth noting. Primarily, there are fewer standards and each grade level focuses on the big ideas for each of these sub-disciplines: physical science; earth science; life science; and science, technology and engineering. The overarching organization of the standards has also changed; they are divided into two sections: Process Standards and Content Standards, which are described in greater detail below.

Process Standards

The Process Standards are the processes and skills that students are expected to learn and be able to do within the context of the science content. The separation of the Process Standards from the Content Standards is intentional; in doing so we want to make explicit the idea that what students are doing while they are learning science is extremely important. The Process Standards reflect the way in which students are learning and doing science and are designed to work in tandem with the science content, resulting in robust instructional practice.

The Process Standards are organized in the following grade bands: K-2, 3-5, 6-8. Within each grade band, the Process Standards address a particular topic or topics. Kindergarten introduces The Nature of Science, while grades 1 through 5, reflect two parts: The Nature of Science and The Design Process. In grades 6 through 8, Reading for Literacy in Science and Writing for Literacy in Science have been added to emphasize these processes in science. For high school, the Process Standards include Reading and Writing for Literacy in Science as well as The Nature of Science.

As noted in the previous paragraph, grades 6 through 8 and high school content courses will include Reading and Writing for Literacy in Science. It is important to note that these Process Standards emerged with the adoption of the Common Core State Standards in the area of Reading and Writing for Literacy in Science. The Literacy Standards establish that instruction in reading, writing, speaking, listening, and language is a shared responsibility. The Literacy Standards are predicated on teachers in the content areas using their unique disciplinary expertise to help students meet the particular challenges of reading, writing, speaking, listening, and language in their respective fields. It is important to note that the literacy standards are meant to complement rather than supplant content standards in the disciplines.

Part of the motivation behind the disciplinary approach to literacy promulgated by the Literacy Standards is extensive research establishing the need for college- and career-ready students

to be proficient in reading complex informational text independently in a variety of content areas. Most of the required reading in college and workforce training programs is informational in structure and challenging in content. Postsecondary education programs typically provide students with both a higher volume of such reading than is generally required in K-12 schools and comparatively little scaffolding.

The Literacy Standards make clear that significant reading of informational texts should also take place outside ELA classrooms in order for students to be ready for college and careers. Future assessments will apply the sum of all the reading students do in a grade, not just their reading in the ELA context. The Literacy Standards demand that a great deal of reading should occur in all disciplines.

The Literacy Standards also cultivate the development of three mutually reinforcing writing capacities: writing to persuade, to explain, and to convey real or imagined experience. College and career readiness requires that writing focus significantly on writing to argue and to inform or explain.

The Literacy Standards use grade level bands to present the standards. Teachers teaching at the beginning of the grade band may need to provide scaffolding for students to be successful, where teachers teaching at the end of the grade band should expect students to demonstrate the standards independently.

Content Standards

In grades 1 through 8, the Content Standards are organized in four distinct areas: 1) physical science; 2) earth science; 3) life science; and 4) science, technology and engineering. Kindergarten has only the first three areas: physical, earth and life science. In each of these areas there is at least one core standard, which serves as the big idea at that grade level for that content area. For the high school science courses, the content standards are organized around the core ideas in each particular course, which are represented by the core standard. The core standard is not meant to stand alone or be used as an individual standard, but instead is meant to help teachers organize their instruction around the “big ideas” in that content area and for grades K-8, at that particular grade level. Beneath each core standard are indicators which serve as the more detailed expectations within each of the content areas.

Finally, in the development of these revised science standards, careful attention was paid to how ideas are articulated across the grade levels so that content and skills that students will need to succeed in a particular sub-discipline are introduced in an appropriate manner in the early elementary grades and then progressed as students move towards high school.

Biology I

Process Standards

The Nature of Science

Scientific knowledge is scientists' best explanations for the data from many investigations. Ideas about objects in the microscopic world that we cannot directly sense are often understood in terms of concepts developed to understand objects in the macroscopic world that we can see and touch. Student work should align with this process of science and should be guided by those principles. Students should also understand that scientific knowledge is gained from observation of natural phenomena and experimentation by designing and conducting investigations guided by theory and by evaluating and communicating the results of those investigations according to accepted procedures. These concepts should be woven throughout daily work.

- Develop explanations based on reproducible data and observations gathered during laboratory investigations.
- Recognize that their explanations must be based both on their data and other known information from investigations of others.
- Clearly communicate their ideas and results of investigations verbally and in written form using tables, graphs, diagrams and photographs.
- Regularly evaluate the work of their peers and in turn have their work evaluated by their peers.
- Apply standard techniques in laboratory investigations to measure physical quantities in appropriate units and convert quantities to other units as necessary.
- Use analogies and models (mathematical and physical) to simplify and represent systems that are difficult to understand or directly experience due to their size, time scale or complexity. Recognize the limitations of analogies and models.
- Focus on the development of explanatory models based on their observations during laboratory investigations.
- Explain that the body of scientific knowledge is organized into major theories, which are derived from and supported by the results of many experiments and allow us to make testable predictions.
- Recognize that new scientific discoveries often lead to a re-evaluation of previously accepted scientific knowledge and of commonly held ideas.
- Describe how scientific discoveries lead to the development of new technologies and conversely how technological advances can lead to scientific discoveries through new experimental methods and equipment.
- Explain how scientific knowledge can be used to guide decisions on environmental and social issues.

Reading Standards for Literacy in Science

The standards below begin at grade 9 and define what students should understand and be able to do by the end of grade 10.

Key Ideas and Details

- 9-10.RS.1** Cite specific textual evidence to support analysis of science texts, attending to the precise details of explanations or descriptions.
- 9-10.RS.2** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- 9-10.RS.3** Follow precisely a complex multistep procedure when carrying out experiments or taking measurements, attending to special cases or exceptions defined in the text.

Craft and Structure

- 9-10.RS.4** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific context relevant to *grades 9-10 texts and topics*.
- 9-10.RS.5** Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
- 9-10.RS.6** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

- 9-10.RS.7** Translate quantitative information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- 9-10.RS.8** Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific problem.
- 9-10.RS.9** Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

- 9-10.RS.10** By the end of grade 10, read and comprehend science texts in the grades 9-10 text complexity band independently and proficiently.

Writing Standards for Literacy in Science

Text Types and Purposes

- 9-10.WS.1** Write arguments focused on *discipline-specific content*.
- Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
 - Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
 - Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
 - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
 - Provide a concluding statement or section that follows from or supports the argument presented.
- 9-10.WS.2** Write informative/explanatory texts, including scientific procedures/experiments.
- Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
 - Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
 - Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
 - Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
 - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
 - Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

- 9-10.WS.3** *Note: Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In science, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations that others can replicate them and (possibly) reach the same results.*

Production and Distribution of Writing

- 9-10.WS.4** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- 9-10.WS.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- 9-10.WS.6** Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

- 9-10.WS.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- 9-10.WS.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectivity to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
- 9-10.WS.9** Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

- 9-10.WS.10** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Content Standards

Standard 1: Cellular Chemistry

Core Standard

Describe the basic molecular structure and function of the four major categories of organic compounds (carbohydrates, lipids, proteins and nucleic acids) essential to cellular function. (B.1.1)

Core Standard

Describe how work done in cells is performed by a variety of organic molecules—especially proteins, whose functions depend on the sequence of their monomers and the consequent shape of the molecule. (B.1.2, B.1.3)

- B.1.1 Describe the structure of the major categories of organic compounds that make up living organisms in terms of their building blocks and the small number of chemical elements (i.e., carbon, hydrogen, nitrogen, oxygen, phosphorous and sulfur) from which they are composed.
- B.1.2 Understand that the shape of a molecule determines its role in the many different types of cellular processes (e.g., metabolism, homeostasis, growth and development, and heredity) and understand that the majority of these processes involve proteins that act as enzymes.
- B.1.3 Explain and give examples of how the function and differentiation of cells is influenced by their external environment (e.g., temperature, acidity and the concentration of certain molecules) and changes in these conditions may affect how a cell functions.

Standard 2: Cellular Structure

Core Standard

Describe features that are common to all cells and contrast those with distinctive features that allow cells to carry out specific functions.

- B.2.1 Describe features common to all cells that are essential for growth and survival. Explain their functions.
- B.2.2 Describe the structure of a cell membrane and explain how it regulates the transport of materials into and out of the cell and prevents harmful materials from entering the cell.
- B.2.3 Explain that most cells contain mitochondria (the key sites of cellular respiration), where stored chemical energy is converted into useable energy for the cell. Explain that some

cells, including many plant cells, contain chloroplasts (the key sites of photosynthesis) where the energy of light is captured for use in chemical work.

- B.2.4 Explain that all cells contain ribosomes (the key sites for protein synthesis), where genetic material is decoded in order to form unique proteins.
- B.2.5 Explain that cells use proteins to form structures (e.g., cilia, flagella), which allow them to carry out specific functions (e.g., movement, adhesion and absorption).
- B.2.6 Investigate a variety of different cell types and relate the proportion of different organelles within these cells to their functions.

Standard 3: Matter Cycles and Energy Transfer

Core Standard

Describe how the sun's energy is captured and used to construct sugar molecules that can be used as a form of energy or serve as building blocks of organic molecules. (B.3.1, B.3.2, B.3.3)

Core Standard

Diagram how matter and energy cycle through an ecosystem. (B.3.4, B.3.5)

- B.3.1 Describe how some organisms capture the sun's energy through the process of photosynthesis by converting carbon dioxide and water into high-energy compounds and releasing oxygen.
- B.3.2 Describe how most organisms can combine and recombine the elements contained in sugar molecules into a variety of biologically essential compounds by utilizing the energy from cellular respiration.
- B.3.3 Recognize and describe that metabolism consists of all of the biochemical reactions that occur inside cells, which include the production, modification, transport, and exchange of materials that are required for the maintenance of life.
- B.3.4 Describe how matter cycles through an ecosystem by way of food chains and food webs and how organisms convert that matter into a variety of organic molecules to be used in part in their own cellular structures.
- B.3.5 Describe how energy from the sun flows through an ecosystem by way of food chains and food webs and how only a small portion of that energy is used by individual organisms while the majority is lost as heat.

Standard 4: Interdependence

Core Standard

Describe the relationship between living and nonliving components of ecosystems and describe how that relationship is in flux due to natural changes and human actions.

- B.4.1 Explain that the amount of life environments can support is limited by the available energy, water, oxygen and minerals and by the ability of ecosystems to recycle the remains of dead organisms.
- B.4.2 Describe how human activities and natural phenomena can change the flow and of matter and energy in an ecosystem and how those changes impact other species.
- B.4.3 Describe the consequences of introducing non-native species into an ecosystem and identify the impact it may have on that ecosystem.
- B.4.4 Describe how climate, the pattern of matter and energy flow, the birth and death of new organisms, and the interaction between those organisms contribute to the long-term stability of an ecosystem.

Standard 5: Molecular Basis of Heredity

Core Standard

Describe the basic structure of DNA and how this structure enables DNA to function as the hereditary molecule that directs the production of RNA and proteins. (B.5.1, B.5.2, B.5.3)

Core Standard

Understand that proteins largely determine the traits of an organism. (B.5.4, B.5.5, B.5.6)

- B.5.1 Describe the relationship between chromosomes and DNA along with their basic structure and function.
- B.5.2 Describe how hereditary information passed from parents to offspring is encoded in the regions of DNA molecules called genes.
- B.5.3 Describe the process by which DNA directs the production of protein within a cell.
- B.5.4 Explain how the unique shape and activity of each protein is determined by the sequence of its amino acids.

- B.5.5 Understand that proteins are responsible for the observable traits of an organism and for most of the functions within an organism.
- B.5.6 Recognize that traits can be structural, physiological or behavioral and can include readily observable characteristics at the organismal level or less recognizable features at the molecular and cellular level.

Standard 6: Cellular Reproduction

Core Standard

Explain the processes (i.e., mitosis and meiosis) by which new cells are formed from existing cells and how in multicellular organisms groups of cells cooperate to perform essential functions within the organisms. (B.6.1, B.6.2, B.6.3)

Core Standard:

Explain the cellular processes that occur to generate natural genetic variations between parents and offspring. (B.6.4, B.6.5)

- B.6.1 Describe the process of mitosis and explain that this process ordinarily results in daughter cells with a genetic make-up identical to the parent cells.
- B.6.2 Understand that most cells of a multicellular organism contain the same genes but develop from a single cell (e.g., a fertilized egg) in different ways due to differential gene expression.
- B.6.3 Explain that in multicellular organisms the zygote produced during fertilization undergoes a series of cell divisions that lead to clusters of cells that go on to specialize and become the organism's tissues and organs.
- B.6.4 Describe and model the process of meiosis and explain the relationship between the genetic make-up of the parent cell and the daughter cells (i.e., gametes).
- B.6.5 Explain how in sexual reproduction that crossing over, independent assortment and random fertilization result in offspring that are genetically different from the parents.

Standard 7: Genetics

Core Standard

Explain how the genetic information from parents determines the unique characteristics of their offspring.

- B.7.1 Distinguish between dominant and recessive alleles and determine the phenotype that would result from the different possible combinations of alleles in an offspring.
- B.7.2 Describe dominant, recessive, codominant, sex-linked, incompletely dominant, multiply allelic and polygenic traits and illustrate their inheritance patterns over multiple generations.
- B.7.3 Determine the likelihood of the appearance of a specific trait in an offspring given the genetic make-up of the parents.
- B.7.4 Explain the process by which a cell copies its DNA and identify factors that can damage DNA and cause changes in its nucleotide sequence.
- B.7.5 Explain and demonstrate how inserting, substituting or deleting segments of a DNA molecule can alter a gene, how that gene is then passed to every cell that develops from it and how the results may be beneficial, harmful or have little or no effect on the organism.

Standard 8: Evolution

Core Standard

Describe how biochemical, fossil, anatomical, developmental, and genetic findings are used to determine relationships among organisms and how those relationships are then used to produce modern classification systems. (B.8.1, B.8.2, B.8.3, B.8.4)

Core Standard

Describe how modern evolutionary theory provides an explanation of the history of life on earth and the similarities among organisms that exist today. (B.8.5, B.8.6, B.8.7)

- B.8.1 Explain how anatomical and molecular similarities among organisms suggests that life on earth began as simple, one-celled organisms about 4 billion years ago and multicellular organisms evolved later.
- B.8.2 Explain how organisms are classified and named based on their evolutionary relationships into taxonomic categories.
- B.8.3 Use anatomical and molecular evidence to establish evolutionary relationships among organisms.
- B.8.4 Understand that molecular evidence supports the anatomical evidence for these evolutionary relationships and provides additional information about the order in which different lines of descent branched.

- B.8.5 Describe how organisms with beneficial traits are more likely to survive, reproduce, and pass on their genetic information due to genetic variations, environmental forces and reproductive pressures.
- B.8.6 Explain how genetic variation within a population (i.e., a species) can be attributed to mutations as well as random assortments of existing genes.
- B.8.7 Describe the modern scientific theory of the origins and history of life on earth and evaluate the evidence that supports it.