

## 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.

# Anatomy and Physiology

## 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

### Key Ideas and Details

- 11-12.RS.1** Cite specific textual evidence to support analysis of science, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- 11-12.RS.2** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- 11-12.RS.3** Follow precisely a complex multistep procedure when carrying out experiments or taking measurements; analyze the specific results based on explanations in the text.

### Craft and Structure

- 11-12.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 11-12 texts and topics*.
- 11-12.RS.5** Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
- 11-12.RS.6** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

### Integration of Knowledge and Ideas

- 11-12.RS.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- 11-12.RS.8** Evaluate the hypotheses, data, analysis, and conclusions in a science text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- 11-12.RS.9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

### Range of Reading and Level of Text Complexity

- 11-12.RS.10** By the end of grade 12 read and comprehend science texts in the grades 11-CCR text complexity band independently and proficiently.

## Writing Standards for Literacy in Science

### Text Types and Purposes

- 11-12.WS.1** Write arguments focused on *discipline-specific content*.
- Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
  - Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
  - Use words, phrases, and clauses as well as varied syntax 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.
- 11-12.WS.2** Write informative/explanatory texts, including scientific procedures/experiments.
- Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
  - Develop the topic thoroughly by selecting the most significant and relevant 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 complex ideas and concepts.
  - Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
  - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

**11-12.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**

**11-12.WS.4** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

**11-12.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.

**11-12.WS.6** Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

### **Research to Build and Present Knowledge**

**11-12.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.

**11-12.WS.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

**11-12.WS.9** Draw evidence from informational texts to support analysis, reflection, and research.

### **Range of Writing**

**11-12.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: Levels of Organization in the Human Body: Cellular

---

#### **Core Standard**

Describe the different forms of cellular transport within the cell and across the plasma membrane. (AP.1.1, AP.1.2, AP.1.3)

#### **Core Standard**

Discuss the stages and processes of somatic cell division and investigate cellular differentiation in the course of development and in the adult body. (AP.1.4)

---

- AP.1.1 Compare and contrast diffusion and osmosis, facilitated diffusion, active transport, endocytosis, and exocytosis.
- AP.1.2 Define homeostasis, its principal mechanisms at the cellular level and the consequences of failure to maintain homeostasis.
- AP.1.3 Describe the importance of proteins in cell function and structure. Give specific examples of proteins and their functions and describe how proteins are synthesized.
- AP.1.4 Review the stages of mitosis and discuss differences in lifespan among various types of terminally differentiated cells.

### Standard 2: Levels of Organization in the Human Body: Tissue and Organs

---

#### **Core Standard**

Examine the role of adhesion molecules and how these contribute to tissue formation. (AP.2.1)

#### **Core Standard**

Analyze the relationships among and the histology and physiological functions of tissues and their cellular and biochemical composition. (AP.2.2, AP.2.3, AP.2.4, AP.2.5)

---

- AP.2.1 Explain the interactions that exist among cells within multicellular organisms to produce tissues and organs with distinct functions.
- AP.2.2 Compare and contrast the structure, function and location of cells that make up the various types of muscle tissue, nerve tissue and connective tissue.
- AP.2.3 Describe the general cellular structure of an epithelium, including the basement membrane. Describe the different types and locations of epithelia.

- AP 2.4 Describe endocrine and exocrine glands and their development from glandular epithelium.
- AP 2.5 Describe the body cavities, their membranes, and the organs within each cavity and their role in the functioning of the body. Describe the major organ systems and their role in the functioning of the body.

### **Standard 3: Movement and Support in the Human Body: The Integumentary System**

---

#### ***Core Standard***

Analyze the structures of the skin, including skin layers as well as accessory structures (e.g, hair follicles, glands and nails). (AP.3.1, AP.3.2)

#### ***Core Standard***

Describe the function of the integumentary system and the cause and effect of diseases associated with the integumentary system. (AP.3.3, AP.3.4)

---

- AP.3.1 Describe the structure of the skin, including the hypodermis, dermis and the layers of the epidermis.
- AP.3.2 Describe the accessory structures of the skin (i.e., hairs, nails and glands).
- AP.3.3 Describe the important physiological functions of the skin.
- AP.3.4 Evaluate the cause and effect of diseases associated with the integumentary system.

### **Standard 4: Movement and Support in the Human Body: The Skeletal System**

---

#### ***Core Standard***

Describe the structure, development, growth and functions of bones.

---

- AP 4.1 Describe the structure of a typical long bone and indicate how each part functions in the physiology and growth of the bone.
- AP 4.2 Distinguish the axial from the appendicular skeleton and name the major bones of each. Locate and identify the bones and the major features of the bones that make up the skull, vertebral column, thoracic cage, pectoral girdle, upper limb, pelvic girdle and lower limb.

- AP 4.3 Compare and contrast the microscopic organization of compact (i.e., cortical) bone and spongy (i.e., trabecular) bone.
- AP 4.4 Describe the major types of joints in terms of their mobility and the tissues that hold them together.
- AP 4.5 Analyze and describe the effects of pressure, movement, torque, tension and elasticity on the human body.

## **Standard 5: Movement and Support in the Human Body: The Muscular System**

---

### ***Core Standard***

Describe the physiology and structure of skeletal, smooth and cardiac muscle as they interact to provide movement and support of the human body.

### ***Core Standard***

Compare and contrast the microscopic structure, organization, functions and molecular basis of contraction in skeletal, smooth and cardiac muscle.

---

- AP 5.1 Name the components of a skeletal muscle fiber and describe their functions. Describe how the thin and thick filaments are organized in the sarcomere.
- AP 5.2 Explain the molecular processes and biochemical mechanisms that provide energy for muscle contraction and relaxation.
- AP 5.3 Describe a motor unit and its importance in controlling the force and velocity of muscle contraction. Describe the neuromuscular junction and the neurotransmitter released at the neuromuscular junction.
- AP 5.4 Distinguish between isotonic and isometric contractions of skeletal muscle; cite examples of each and discuss how the forces generated in muscle contraction are amplified by the use of levers.
- AP 5.5 Identify the major muscles on a diagram of the body's musculature, through dissection or both. Describe the movements associated with each muscle.
- AP 5.6 Explain what is meant by muscular hypertrophy and atrophy and discuss causes of these processes.

## Standard 6: Integration and Coordination in the Human Body: The Nervous System

---

### **Core Standard**

Recognize that the nervous system consists of two parts: the peripheral nervous system and the central nervous system. Understand the structure and function of each.

### **Core Standard**

Recognize uses of contemporary electrophysiological technologies (e.g. electroencephalogram, electrocardiogram, transcutaneous electrical nerve stimulation and cardioversion).

---

- AP 6.1 Distinguish the structures of the various types of neurons. Diagram the structure of a motor neuron and explain the function of each of its parts.
- AP 6.2 Describe the different types of neuroglia. Describe the function of oligodendrocytes and Schwann cells. Describe the structure and function of the myelin sheath and the role that Schwann cells play in myelin and in regeneration of a severed axon.
- AP 6.3 Discuss mathematically the origin of the resting potential. Refer to transcellular gradients of sodium and potassium ions, the “permeability” of the plasma membrane to these ions, and the intracellular concentration of negatively-charged proteins.
- AP 6.4 Explain the changes in membrane potential during the action potential and their relationship to the number of open channels for sodium and potassium ions.
- AP 6.5 Explain the role of excitatory and inhibitory neurotransmitters. Explain why is it important to remove a neurotransmitter from its site of action and describe two mechanisms for removal.
- AP 6.6 Describe the meninges of brain and spinal cord. Describe the cerebral ventricles and their interconnections. Describe the secretion, flow pathways, absorption, locations and functions of cerebrospinal fluid.
- AP 6.7 Discuss the functions of the spinal cord. Describe the five segments (i.e., regions) of the spinal cord and explain its organization in terms of gray matter; white matter; and dorsal and ventral roots.
- AP 6.8 Discuss the components and broad function of the brain stem and the diencephalon. Describe and give the functions of the various structures that make up the cerebrum including the cerebral cortex and its anatomical divisions, the cerebral components of the basal ganglia, and the corpus callosum.
- AP 6.9 Describe the structure and functions of the cerebellum and its nuclei regarding postural control, smooth coordination of movements and motor learning.

AP 6.10 Describe the major characteristics of the autonomic nervous system and contrast its efferent pathways with those of somatic nervous system. Compare and contrast the actions, origins and pathways of nerve fibers in the parasympathetic and sympathetic divisions of the autonomic nervous system including their associated ganglia and neurotransmitters.

## **Standard 7: Integration and Coordination in the Human Body: Somatic and Special Senses**

---

### **Core Standard**

Distinguish between somatic senses and special senses and classify sensory receptors according to the types of stimuli that activate them.

---

- AP 7.1 Explain how information on stimulus intensity and stimulus quality is signaled to the brain.
- AP 7.2 Explain what is meant by sensory receptor adaptation and give examples related to everyday experience.
- AP 7.3 Describe the structure, function and location of olfactory and taste receptor cells.
- AP 7.4 Identify and describe the parts of the eye. Describe the cells found in the neural retina and the functional dependence of the rods and cones on the pigmented epithelium (i.e., the non-neural retina).
- AP 7.5 Compare the structures of rods and cones, describe the fovea and its function, and discuss the relationship of rods and cones to visual acuity, night vision, dark-adaptation, color vision and color blindness.
- AP 7.6 Describe the three regions of the ear. Distinguish the structure and function of the vestibular apparatus from the auditory apparatus. Describe how sound is transmitted from the external auditory meatus to the cochlea.
- AP 7.7 Explain how the hair cells in the vestibular apparatus and cochlea respond to head tilt, linear acceleration, rotation and sound.

## **Standard 8: Integration and Coordination in the Human Body: The Endocrine System**

---

### ***Core Standard***

Understand the structure and function of the endocrine system in relation to homeostasis, Include a discussion of the specific role of hormones and distinguish between the endocrine glands and endocrine secretory cells found in other organs.

---

- AP 8.1 Discuss the difference between an endocrine gland and an exocrine gland.
- AP 8.2 Explain the nature of a hormone and the endocrine system in relation to digestion and metabolism, homeostasis, growth, development, and reproduction.
- AP 8.3 Identify the chemical classes to which important hormones belong and explain that some hormones act via second messengers.
- AP 8.4 Discuss chemical signals that can control hormone secretion.
- AP 8.5 Describe the structure and hormones of the hypothalamus-pituitary complex and the function of these hormones in controlling the thyroid, gonads and adrenal cortex. Describe the structure of these glands and the functions of the hormones secreted by them.
- AP 8.6 For glands that are not under the control of the hypothalamus-pituitary complex, describe their structure, the hormones they secrete and their function, and the stimuli for secretion.
- AP 8.7 Discuss how the hypothalamus-pituitary complex, the sympathetic nervous system, the adrenal medulla and the adrenal cortex are all involved in the body's response to stress.
- AP 8.8 Explain how the cells of the adrenal medulla supplement the actions of the autonomic nervous system.

## **Standard 9: Transport in the Human Body: The Blood**

---

### ***Core Standard***

Define hemostasis and how it is achieved.

### ***Core Standard***

Analyze the functions of blood including its role in responding to invading microorganisms, its defense mechanisms (e.g., acute inflammation) and the immune response.

---

- AP 9.1 Distinguish whole blood from plasma and serum. Classify and explain the functions of the formed elements found in blood and describe where they are produced.
- AP 9.2 Describe how erythropoietin regulates red blood cell production.
- AP 9.3 Explain the ABO blood types and their significance in blood transfusion.
- AP 9.4 Describe the basic processes in blood clotting.

## **Standard 10: Transport in the Human Body: The Cardiovascular System**

---

### ***Core Standard***

Identify and locate the organs of the cardiovascular system and discuss their functions.

### ***Core Standard***

Analyze the cardiac cycle and explain how it is controlled.

---

- AP 10.1 Describe the layers found in the walls of blood vessels and discuss the relative prominence of these layers in the different types of blood vessels. Include an analysis of vasoconstriction and vasodilation and their importance in controlling blood flow through tissues. Describe both the venous pump and varicose veins.
- AP 10.2 Diagram the structure of a capillary bed and explain how materials move in and out of capillaries.
- AP 10.3 Describe the heart and include the pericardium, the layers in its wall, the four chambers, the valves, and the great vessels entering and leaving the heart. Describe the major arteries branching off from the aorta and the regions they supply. Describe the major veins entering the superior and inferior venae cavae. Explain with diagrams how the heart valves ensure one-way blood flow during systole and diastole. Discuss the heart sounds and the points in the cardiac cycle when they are heard.
- AP 10.4 Discuss the importance of the baroreceptor reflex in the regulation of blood pressure. Explain what is meant by hypertension and mention some of the dangers associated with it.
- AP 10.5 Describe how the action potential of a cardiac muscle cell differs from that of a neuron. Describe the importance of calcium ion influx during the plateau phase of the action potential. Discuss the functioning of pacemaker cells and the how the wave of depolarization is transmitted to the ventricles.

- AP 10.6 Explain the adjustment of the cardiovascular system to exercise and how it relates to hemorrhage. Contrast changes in the distribution of blood flow and cardiac output and explain the importance of the sympathetic branch of the autonomic nervous system in these responses.

### **Standard 11: Transport in the Human Body: The Lymphatic System and Immune Mechanisms**

---

#### ***Core Standard***

Identify and locate major organs of the lymphatic system and discuss their functions.

#### ***Core Standard***

Illustrate lines of defense including the cellular and non-cellular components of the immune system.

---

- AP 11.1 Discuss the major anatomical structures and functions of the lymphatic system including the lymphatic vessels, the structure and major groupings of lymph nodes, and the structures and functions of the spleen, thymus and bone marrow.
- AP 11.2 Discuss the different types of pathogens and outline the strategies the body uses to protect itself from them. Compare and contrast non-specific, innate or natural immunity from specific or acquired immunity.
- AP 11.3 Describe the mechanisms of the acute inflammatory response, its causes and the role of chemical signaling molecules.
- AP 11.4 Describe the development and maturation of B- and T-lymphocytes. Discuss why the development of self-tolerance is important.
- AP 11.5 Define and discuss antigens, antibodies and complement.

### **Standard 12: Absorption and Excretion in the Human Body: The Digestive System**

---

#### ***Core Standard***

Identify and locate major and accessory organs of the digestive system and discuss their functions.

#### ***Core Standard***

Analyze the digestive processes from ingestion to defecation.

---

- AP 12.1 Describe the functions of all the structural components and enzymes of the gastrointestinal tract and accessory organs in relation to the processing, digesting, and absorbing of the three major food classes.
- AP 12.2 Explain the roles of the lacteals and the hepatic portal vein in transporting the products of digestion.
- AP 12.3 Describe the regulation of the enzyme and bicarbonate content of the pancreatic juice.
- AP 12.4 Explain the difference between metabolic and respiratory acidosis and alkalosis.
- AP 12.5 Describe the microscopic anatomy of the liver and its relationship to the functions of the liver.

### **Standard 13: Absorption and Excretion in the Human Body: The Respiratory System**

---

#### ***Core Standard***

Identify and locate major organs of the respiratory system and discuss their functions.

#### ***Core Standard***

Analyze the breathing processes (i.e., inspiration, expiration, respiratory volumes and capacities).

---

- AP 13.1 Contrast inspiration and expiration (i.e., quiet and forced) and explain the role of various muscles and of lung elasticity in this process.
- AP 13.2 Compare the percentages of the oxygen and carbon dioxide in the external air to the percentages in the alveolar and the pulmonary capillaries. Explain the meaning of partial pressure.
- AP 13.3 Explain the use of the spirometer and describe the data it generates in a spirogram.
- AP 13.4 Describe the neuronal networks controlling respiration. Contrast and compare the chemoreceptors involved in control of respiration and the stimuli to which they respond. Explain how these receptors affect ventilation under conditions of low arterial oxygen partial pressure, high arterial carbon dioxide and low arterial pH.

### **Standard 14: Absorption and Excretion in the Human Body: The Urinary System**

---

#### ***Core Standard***

Identify and locate major organs of the urinary system and discuss their functions.

**Core Standard**

Understand the function of the kidneys in relation to homeostatic control of bodily fluids, blood pressure and erythrocyte production.

---

- AP 14.1 Describe the external and internal structure of the kidney. Describe the parts of a nephron and how it is involved in the three steps in the production of urine. Compare the composition of plasma and ultrafiltrate and discuss the percentages of filtered water, sodium and glucose normally reabsorbed by the kidney tubules.
- AP 14.2 Explain the importance of the juxtaglomerular cells in the secretion of renin and how it plays a central role in controlling blood pressure by controlling blood levels of angiotensin and aldosterone.
- AP 14.3 Explain the neural basis of micturition including the function of the sphincters associated with the male and female urethra.
- AP 14.4 Discuss how the volume of body fluid is determined by the balance between ingested and metabolic water on the one hand and water lost in the urine, respiration, feces and sweating on the other hand.
- AP 14.5 Describe how the kidneys respond to excess water intake and to dehydration. Explain the role of antidiuretic hormone and of other hormones that control sodium and water absorption in the kidney.
- AP 14.6 Describe how food and metabolic processes add acid to the body fluids. Recognize how chemical buffers, the lungs and the kidneys interact in protecting the body against lethal changes of pH.

**Standard 15: Life Cycle in the Human Body: The Reproductive System**

---

**Core Standard**

Identify and locate major and accessory organs of the female and male reproductive systems and discuss their functions (e.g., oogenesis and spermatogenesis).

**Core Standard**

Discuss the role of hormones in the reproductive system.

---

- AP 15.1 Discuss the anatomy and physiology of the male and female reproductive systems.

- AP 15.2 Compare and contrast oogenesis and spermatogenesis. Distinguish between diploid germ cells and haploid or monoploid sex cells.
- AP 15.3 Describe the hormones of the gonads, their cellular origins and their functions. Explain the functions of the gonadotropins FSH and LH in males and females.
- AP 15.4 Explain what is happening during the follicular, ovulatory and luteal phases of the menstrual cycle. Describe how estradiol and progesterone released by the ovaries are responsible for the phases that the uterus goes through during the menstrual cycle.
- AP 15.5 Describe how spermatozoa move through the female reproductive tract and describe the process of fertilization.
- AP 15.6 Explain the differences among a dikaryon zygote, a zygote, a morula and a blastocyst. Recognize that the implanted blastocyst secretes human gonadotropin, which prolongs the life of the corpus luteum and therefore maintains progesterone secretion. Describe the process of implantation and development of the placenta, the substances that move across it and the role of the placenta in maintaining the fetus.
- AP 15.7 Describe the changes in the breast leading to lactation, the hormonal events that initiate milk secretion, the maintenance of milk secretion by the breasts and the milk ejection reflex.