## Introduction to Indiana's Academic Standards for Biomedical Sciences

Indiana's Academic Standards for Biomedical Sciences were created to clarify the areas and content that is in the biomedical area. This new document, Indiana's Academic Standards for Biomedical Sciences, reflects the ever-changing science content and the underlying premise that science education should be an inquiry-based, hands-on experience.

Indiana's Academic Standards for Biomedical Sciences reflect the addition of the Common Core Literacy standards Adopted by Indiana in 2010. The standards are divided into two sections: Content Standards and Process Standards, which are described in greater detail below.

## Content Standards

For the high school science courses, the content standards are organized around the domains 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 each domain. Beneath each core standard are standards which serve as the more detailed expectations within each of the topics.

## 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.

As noted in the previous paragraph, Biomedical Sciences courses 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.

Indiana Department of Education
Indiana Academic Standards Content Framework

## PLTW Principles of Biomedical Sciences

*PLTW Principles of Biomedical Sciences* provides an introduction to this field through "hands-on" projects and problems. Student work involves the study of human medicine, research processes and an introduction to bioinformatics. Students investigate the human body systems and various health conditions including heart disease, diabetes, hypercholesterolemia, and infectious diseases. A theme through the course is to determine the factors that led to the death of a fictional person. After determining the factors responsible for the death, the students investigate lifestyle choices and medical treatments that might have prolonged the person's life.

Key biological concepts included in the curriculum are: homeostasis, metabolism, inheritance of traits, feedback systems, and defense against disease. Engineering principles such as the design process, feedback loops, fluid dynamics, and the relationship of structure to function will be included where appropriate. The course is designed to provide an overview of all courses in the Biomedical Sciences program and to lay the scientific foundation necessary for student success in the subsequent courses. Schools must agree to be part of the Project Lead the Way network and follow all training and data collection requirements. **NOTE: Use of the PLTW Course number is limited to schools that have agreed to be part of the Project Lead the Way network and follow all training and data collection requirements.**

- DOE Code: 5218
- Recommended Grade Level: 9$^{th}$ grade or permission from instructor
- Recommended Prerequisites: Biology I or concurrent enrollment in Biology I is required
- Credits: 1 credit per semester, 2 semesters maximum, maximum of 2 credits
- Counts as a Directed Elective or Elective for the General, Core 40, Core 40 with Academic Honors and Core 40 with Technical Honors diplomas
- Fulfills a Core 40 Science elective requirement for the General, Core 40, Core 40 with Academic Honors and Core 40 with Technical Honors diplomas or counts as an Elective or Directed Elective for any diploma
- This course is aligned with the following Post-Secondary courses for Dual Credit:
    - IUPUI
        - BIOL 10011: Principles of Biomedical Science
    - Ivy Tech
        - TBD

**Dual Credit**
This course provides the opportunity for dual credit for students who meet postsecondary requirements for earning dual credit and successfully complete the dual credit requirements of this

course.

**Application of Content and Multiple Hour Offerings**
Intensive laboratory applications are a component of this course and may be either school based or work based or a combination of the two. Work-based learning experiences should be in a closely related industry setting. Instructors shall have a standards-based training plan for students participating in work-based learning experiences.

**Career and Technical Student Organizations (CTSOs)**
Career and Technical Student Organizations are considered a powerful instructional tool when integrated into Career and Technical Education programs. They enhance the knowledge and skills students learn in a course by allowing a student to participate in a unique program of career and leadership development. Students should be encouraged to participate HOSA Health Occupations Student Association the CTSO for this area.

## Content Standards

**Domain 1 – Human Body Systems**

**Core Standard 1** Students investigate the six major human body systems. Students explore what it means to be a system, relate principles of engineering to systems, and investigate the interrelatedness of human body systems. Students learn about the role of medical examination in determining unknown causes of death.

**Standards**

PBS-1.1 Identify the six major human body systems and their functions. Understand that these systems work together to maintain good health.

PBS-1.2 Identify and locate specific organs that comprise the six major human body systems. Describe the function of each organ.

PBS-1.3 Recognize that organs are composed of specific types of tissues, which are composed of specific cells that operate both independently and interdependently of each other. Know that these cells are the fundamental functional units within all living organisms.

PBS-1.4 Define the terms mechanical engineering, bioengineering, fluid mechanics and materials science. Describe how these fields of engineering apply to human body systems.

PBS-1.5 Demonstrate how parts of human body systems work together to perform the job of the entire system.

PBS-1.6 Identify diseases and conditions that can disrupt the functioning of cells, tissues and organs within a human body system. Understand that evidence can be seen post-mortem through medical examination.

PBS-1.7 Describe the aspects involved in determining cause of death, including the medical condition of a victim, in-depth scientific research, the use of medical technology and the involvement of multiple medical professionals.

PBS-1.8 Discuss the role of a coroner, a medical examiner and an emergency medical technician in determining the cause of a death.

**Domain 2 – Heart Attack**

**Core Standard 2** Students focus on the circulatory system and its role in maintaining homeostasis by

examining the structure and function of the heart. Students are introduced to experimental design and software (i.e., EKG, stress test) to collect and analyze heart data including: heart rate, blood pressure and heart function.

**Standards**

PBS-2.1 Describe the characteristics of a simple pump.

PBS-2.2 Demonstrate how a two-chambered pump works.

PBS-2.3 Recognize that the human heart is a four-chambered living pump that provides the force needed to transport blood throughout the body.

PBS -2.4 Identify the structures and functions of the heart.

PBS -2.5 Compare and contrast the characteristics and functions of the different cardiac tissue types including striated muscle tissue, veins, arteries and capillaries.

PBS -2.6 Describe how the heart operates using basic principles of engineering, such as those found in fluid mechanics.

PBS -2.7 Explain how heartbeat is caused by the contraction of cardiac muscle cells as a result of electrical activity signaled by the autonomic nervous system. Describe how this results in the movement of blood from the heart to the arteries and the rest of the body.

PBS -2.8 Calculate heart rate as the number of heart contractions per unit of time (usually one minute). Recognize that heart rate is used by physicians as one indicator of a person's medical condition.

PBS -2.9 Describe blood pressure as a measure of the force put on the vascular walls by the blood as it is pushed by the cardiac muscles through the vascular system. Recognize that this is one indicator of the overall medical condition of the cardiovascular system.

PBS -2.10 Investigate the internal and external factors that can impact heart function including heart rate and blood pressure. Use experimental design to create and carry out experiments on blood pressure and heart rate.

PBS -2.11 Demonstrate the importance of technology in the biomedical sciences by using software and equipment to collect and analyze cardiovascular data.

PBS -2.12 Recognize that blood is a liquid connective tissue composed of red cells, white cells and platelets suspended in liquid plasma.

PBS -2.13 Recognize that blood is the major transport mechanism for substances that must be distributed throughout the body and must be replenished throughout life.

PBS -2.14 Describe the functions of red cells, white cells and platelets.

PBS -2.15 Use experimental procedures to investigate and explain the limits of the size of cells.

**Domain 3 – Diabetes**

**Core Standard 2** Students investigate how a disease (diabetes) in one system can have serious effects on homeostasis throughout the body. Students are introduced to basic chemistry, the biochemistry of macromolecules, and the relationship of these molecules to metabolic function. The causes, symptoms, treatments and effects of diabetes are studied as well as the lifestyle implications associated with this disease. Students discuss engineering principles involved in feedback loops as related to insulin and

glucose.

**Standards**

PBS-3.1 Recognize that the cells in living tissue are composed of molecules. Build and analyze models for molecules, simple compounds, and macromolecules.

PBS-3.2 Explain that food is composed of molecules and compounds. Describe how energy is stored and released in chemical bonds of molecules and compounds.

PBS-3.3 Distinguish among the structures and functions of carbohydrates, proteins and lipids. Provide evidence that these organic molecules come from food (i.e., recommended daily allowance on food labels, chemical indicators).

PBS-3.4 Describe how homeostasis depends upon many different chemical reactions and large organic molecules.

PBS-3.5 Recognize that enzymes are proteins that regulate reaction rates and that many metabolic processes depend upon enzymes to function properly. Explain the importance of enzymes on maintaining homeostasis in the human body.

PBS-3.6 Demonstrate that enzymes are highly specific, using both lock and key models and induced fit models of enzyme function.

PBS-3.7 Recognize that many systems, living or non-living, operate using feedback mechanisms and that information put into a system causes a reaction within the system. Explain the difference between negative and positive feedback.

PBS-3.8 Describe how Insulin regulates the transfer of glucose into cells.

PBS-3.9 Explain the cause, symptoms, effects and treatments of both Type I and Type II diabetes.

PBS-3.10 Demonstrate an understanding of the dietary requirements and restrictions of people who have diabetes and the ways in which diabetes can impact one's daily life.

PBS-3.11 Describe behaviors that could help prevent the onset of Type II diabetes.

PBS-3.12 Describe the four main areas of diabetes research: new technology in equipment, stem cell research, improved drug therapy and organ transplants.

**Domain 4 – Sickle Cell Disease**

**Core Standard 4** Students investigate sickle cell disease to learn the principles of genetics. Students are introduced to bioinformatics and build models of DNA and the beta-globin protein as they study the structure and function of and the relationship between nucleic acids and proteins. To study the impact of mutations, students analyze karyograms and explore the effects of single base-pair mutations

**Standards**

PBS-4.1 Describe the structure and role of hemoglobin in red blood cells.

PBS-4.2 Recognize that changes to the structure of a protein can change its ability to function properly. Describe how changes in the structure of hemoglobin can result in structural changes in red blood cells.

PBS-4.3 Distinguish between normal and sickle red blood cells.

PBS-4.4 Summarize the symptoms and complications of sickle cell disease.

PBS-4.5 Describe the structure and function of deoxyribonucleic acid (DNA).

PBS-4.6 Explain the structure and function of genes by identifying the exons and introns.

PBS-4.7 Demonstrate how the genetic information in DNA molecules provides instructions for assembling protein molecules and that this is virtually the same mechanism for all life forms.

PBS-4.8 Distinguish among the multiple structural levels of proteins. Understand that a protein's shape is not constant; it changes depending on its environment.

PBS-4.9 Illustrate how the sequence of amino acids in a protein determines the protein's structure.

PBS-4.10 Understand that chromosomes carry numerous genes that are passed from parents to offspring in the reproductive cells.

PBS-4.11 Identify some chromosomal abnormalities and describe the syndromes associated with them.

PBS-4.12 Distinguish between chromosomal and gene mutations.

PBS-4.13 Describe the possible outcomes of different types of gene mutations and the corresponding effects on the properties of the resulting protein.

PBS-4.14 Compare the symptoms and complications of sickle cell trait to sickle cell disease.

PBS-4.15 Explain the relationship between the symptoms of anemia and cell energetics.

PBS-4.16 Identify countries with higher incidences of sickle cell disease and investigate the reasons for these occurrences.

PBS-4.17 Create and analyze pedigree charts to illustrate passage of a trait through at least three generations. Calculate the probability of a trait appearing in offspring.

**Domain 5 – Hypercholesterolemia**

**Core Standard 5** Students look at the function of cholesterol in the body and its role in heart disease. Students are introduced to a variety of DNA technologies as they learn about familial hypercholesterolemia genes.

**Standards**

PBS-5.1 Recognize that the type of bond between the carbon atoms in a fatty acid determines whether it is saturated or unsaturated with hydrogen atoms.

PBS-5.2 Compare and contrast the structures and functions of stearic acid, oleic acid, linoleic acid, stearidonic acid and cholesterol.

PBS-5.3 Describe the role of high density lipoprotein (HDL) and low density lipoprotein (LDL) in the transport of cholesterol in the blood. Predict how the ratio of these complexes indicates a person's risk for heart disease.

PBS-5.4 Explain the processes of polymerase chain reaction (PCR), restriction fragment length polymorphism, single nucleotide polymorphisms (SNP), and DNA gel electrophoresis in the diagnosis of genetic diseases and disorders such as the familial hypercholesterolemia.

**Domain 6 – Infectious Diseases**

**Core Standard 6** Students study bacteria and viruses as the causative agents of infectious diseases. Students examine the structural differences between these organisms through Gram staining and producing models. Students investigate the differences in treatment protocols for bacterial and viral diseases. Students learn about public health campaigns that aim to educate individuals about the dangers and preventions of infectious diseases.

**Standards**

PBS-6.1 Distinguish among the different types of bacteria and recognize that only a few cause disease.

PBS-6.2 Classify bacteria by shape, metabolism and reaction to Gram staining.

PBS-6.3 Understand that the efficacy of an antibiotic depends on the type of bacteria causing the infection.

PBS-6.4 Analyze the cause and implications of antibiotic resistance.

PBS-6.5 Describe the structure and role of viruses.

PBS-6.6 Describe the reproductive cycles of viruses.

PBS-6.7 Describe effective and ineffective treatments for viral infections.

PBS-6.8 Summarize the symptoms, prevalence, prevention, treatment, and the global economic and social impact of an infectious disease caused by a virus.

PBS -6.9 Describe various ways in which infectious diseases can be spread

PBS -6.10 Understand how public education can help prevent the spread of some diseases through the promotion of basic personal preventive measures including hand washing, surface cleaning, and using tissues.

## Process Standards

**Common Core Literacy Standards for Technical Subjects**

**Reading Standards for Literacy in Technical Subjects 9-10**

The standards below begin at grade 9 and define what students should understand and be able to do by the end of grade 10. The CCR anchor standards and high school standards in literacy work in tandem to define college and career readiness expectations – the former providing broad standards, the latter providing additional specificity.

**Key Ideas and Details**

9-10.RT.1 Cite specific textual evidence to support analysis of technical texts, attending to the precise details of explanations or descriptions.

9-10.RT.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.RT.3 Follow precisely a complex multistep procedure when performing technical tasks, attending to special cases or exceptions defined in the text.

**Craft and Structure**

9-10.RT.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.RT.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.RT.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 Idea**

9-10.RT.7 Translate technical 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.RT.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a technical problem.

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

**Writing Standards for Literacy in Technical Subjects 9-10**

The standards below begin at grade 9 and define what students should understand and be able to do by the end of grade 10. The CCR anchor standards and high school standards in literacy work in tandem to define college and career readiness expectations – the former providing broad standards, the latter providing additional specificity.

**Text Types and Purposes**

9-10.WT.1 Write arguments focused on *discipline-specific content*.

9-10.WT.2 Write informative/explanatory texts, including technical processes.

9-10.WT.3 Students will not write narratives in technical subjects. *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 technical, students must be able to write precise enough descriptions of the step-by-step procedures they use in their technical work that others can replicate them and (possibly) reach the same results.*

**Production and Distribution of Writing**

9-10.WT.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

9-10.WT.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.WT.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.WT.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.WT.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.WT.9 Draw evidence from informational texts to support analysis, reflection, and research.

**Range of Writing**

9-10.WT.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.