**COMMISSION FOR HIGHER EDUCATION**
Friday, June, 12, 2009

**DECISION ITEM E:** **Acceptance of Project Lead the Way *Principles in Biomedical Sciences* as a Science Elective for Meeting Core 40 Requirements**

**Staff Recommendation**

That the Commission for Higher Education accept Project Lead the Way *Principles in Biomedical Sciences* as a course that can meet the science elective requirement of the Core 40 diploma.

**Background**

In 1994, Indiana's college and business leaders came together with the K-12 community to develop and support the Core 40 curriculum – a single high school curriculum designed to give students the best foundation for success in college and the workforce. In April 2005, the Indiana General Assembly took legislative action to make Core 40 the required curriculum for all students with an opt-out provision and a minimum requirement for admission to Indiana four-year public colleges and universities. This action affects students beginning with those who entered high school in 2007 (Graduating Class of 2011). The Indiana State Board of Education promulgates rules for the adoption of new courses, adopts descriptions of course content, and maintains official lists of courses acceptable for meeting high school graduation or other requirements. Identifying courses that meet Core 40 requirements, however, also requires assent by Indiana's public colleges and universities. The Commission works to facilitate such negotiations.

The Indiana Department of Education organized a team of secondary and postsecondary faculty to identify the competencies that students should acquire from a high school course in Principles in Biomedical Sciences, which would be able to satisfy the "2 credits in any Core 40 Science Course" component of the science requirements for Core 40:

1) 2 credits in Biology I,
2) 2 credits in Chemistry I or Physics I or Integrated Chemistry-Physics, and
3) 2 credits in any Core 40 Science Course.

Commission staff received a request from the Indiana Department of Education to send out the course description and standards to the public colleges and universities for review and acceptance as a Core 40 science course, and review and approval by the Commission. Given that all public institutions have signified that the this course is acceptable as meeting the science elective requirement of the Core 40 diploma, the staff recommends that the Commission do likewise.

**Supporting Document**

*Indiana's Academic Standards for Principles in Biomedical Sciences*

# Indiana’s Academic Standards for Principles in Biomedical Sciences

## Standard 1: Human Body Systems

**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.**

### The Body as a Machine

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.

### Investigating Unknown Causes of Death

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.

## Standard 2: Heart Attack

**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.**

### The Heart as a Pump

PBS.2.1 Describe the characteristics of a simple pump.

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

### The Structure of the Heart

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.

### The Heart at Work

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.

### Blood – The Transport System

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.

## Standard 3: Diabetes

**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.**

### Composition of Food

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.

### Molecules Working Together

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.

### The Diabetes Connection

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.

### Life with 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.

### The Future of 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.

## Standard 4: Sickle Cell Disease

**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**

### Sickle Cell Disease

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| 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. |

### Causes of Sickle Cell Disease

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| 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. |

### Heredity and Mutation

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| 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. |

## Standard 5: Hypercholesterolemia

**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.**

### Cholesterol in the Body

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.

### Molecular Techniques

**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.**

## Standard 6: Infectious Diseases

**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.**

### Bacteria

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.

### Viruses

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.

### Public Health Awareness

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.

**Standard 7: Medical Interventions**

**Students examine medical interventions past and present including surgery, medication, technology and lifestyle choice. Students study how medical interventions have changed over time to prolong and improve the quality of life. Students explore how a new pharmaceutical treatment goes from initial discovery to market. They research medical interventions currently available for common diseases or disorders including heart disease, sickle cell disease, hypercholesterolemia and infectious diseases.**

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| PBS.7.1 | Describe the role of biomedical sciences in the prevention of disease and the development of effective treatments. |
| PBS.7.2 | Research a variety of past and present medical interventions used to prevent and treat disease. Describe how they are used in medical situations. |
| PBS.7.3 | Understand the relationship between the need for medical intervention and the availability of technology. Describe how engineering principles and technology are used in the development of treatment and prevention methods. |
| PBS.7.4 | Demonstrate the steps or stages in the development, trial and approval of medical interventions. |

**Standard 8: Research and Writing in Science**

**Students learn about medical research through the grant writing process. Students prepare a written grant proposal based on a disease or medical condition. Students discern between credible and non-credible sources in order to document and cite research for their grant proposals.**

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| PBS.8.1 | Distinguish between credible and non-credible sources when conducting a literature search. Recognize that the best sources of information have valid credentials and can be checked for accuracy. Cite authors that demonstrate expertise in the given area of research. |
| PBS.8.2 | Distinguish between primary and secondary sources. |
| PBS.8.3 | Demonstrate the ability to correctly document and cite research (i.e., paraphrases, direct quotations, summaries) from a variety of sources (i.e., Internet, journals, textbooks). |
| PBS.8.4 | Understand that medical research is funded through scientific grants, which are detailed proposals describing all aspects of a research project. |
| PBS.8.5 | Identify and describe the main components of a scientific grant proposal (i.e., abstract, specific aims, background and significance, preliminary data/progress, project description, resources, supplemental materials). |
| PBS.8.6 | Write and present a detailed grant proposal requesting funds for a research project to impact a specific aspect of a disease or medical condition. Use a systematic research process (define the topic, gather information, determine credibility, report findings) and a strong writing technique that features main ideas supported by evidence and is organized and presented clearly. |