



Biomedical Sciences Program and Curricula Development Proposal

Project Lead The Way, Inc. – An Overview:

We will create dynamic partnerships with our nation's schools to prepare an increasing and more diverse group of students to be successful in science, engineering, and engineering technology programs.

With this mission Project Lead The Way, Inc. was created in 1996 to address the projected shortage of engineers and engineering technologists in the United States. Starting with 11 high schools in upstate New York, PLTW™ pre-engineering curriculum will be taught in over 1750 high schools and middle schools in September 2006. A 501 (c)(3), not-for-profit organization, Project Lead The Way, Inc. offers four 9-week integrated units of study at the middle school level called *Gateway To Technology*®. Its *Pathways To Engineering*® high school program consists of eight full-year courses and includes:

- *Introduction To Engineering Design*
- *Principles of Engineering*
- *Digital Electronics*
- *Computer Integrated Manufacturing*
- *Civil Engineering and Architecture*
- *Biotechnical Engineering (Indiana funded)*
- *Aerospace Engineering*
- *Engineering Design and Development*

Project Lead The Way, Inc. curricula is contemporary, high rigor and high relevance material, which emphasizes project- and problem-based learning and the development of critical-thinking, problem resolution, and group collaboration skills. Teachers who instruct in the program must participate in a rigorous two-week professional development experience at one of the affiliated universities and colleges for each course that they will teach. Their skills are augmented throughout the academic year by engagement in the PLTW™ *Virtual Academy* where they can download lessons which are intended to reinforce and strengthen their instruction. Since 1998 over 3900 certificates of completion of PLTW™ Summer Teacher Institute training for individual courses were issued to over 2400 teachers. In addition, school counselors are provided in-depth professional development to encourage and support enrollment in PLTW™ courses, especially of girls and underrepresented minorities.

Evaluation of the program has been encouraging with the following positive trends identified:

- College attendance rates of students who have successfully completed three or more PLTW™ courses to 2- and 4-year colleges exceed the rate of their peers by 15% and 24% respectively when compared to the national average (Hezel).
- Students who have successfully completed three or more PLTW™ courses have a higher retention rate in engineering and related majors at the post-secondary level than the national average (RIT, Hezel).
- Students enrolled in PLTW™ courses significantly outperformed their peers on the 2004 National Assessment of Educational Progress (NAEP) exam in mathematics (High Schools That Work, Southern Regional Education Board, Atlanta, GA, May 2005).
- Students enrolled in PLTW™ courses also enrolled in higher levels of mathematics (Algebra 1 through Calculus) and science (Physics) than their peers (High Schools That Work, Southern Regional Education Board, Atlanta, GA, May 2005).

Based on a partnership model, Project Lead The Way, Inc. has attracted the support and backing of industrial interests (Intel Corporation and Rolls Royce), organizations (Indiana Department of Education, NASA and the United States Department of Education), and higher education institutions (Purdue University, Rochester Institute of Technology, Duke University, The Pennsylvania State University and 23 others). There are twenty-four university and college affiliates offering the two-week Summer Teacher Institute and the two-day School Counselor Professional Development Conference, have professors engaged in PLTW curriculum development and assessment design, and offer transferable college course credit to high school students in PLTW™ courses.

The Biomedical Sciences Initiative

Background

Project Lead The Way, Inc. was asked by selected state departments of education, offices of workforce development, and business leaders to develop a parallel program in Biomedical Sciences that would mirror the PLTW™ Engineering program. The Indiana Department of Workforce Development and the Connecticut, Maryland, Missouri, Oklahoma, and South Carolina State Departments of Education have funded work on the first course, *Principles of the Biomedical Sciences*. This request was in recognition of the impending critical shortage of qualified science and health professionals in the United States and the non-existence of a quality instructional program at the secondary school level to prepare students for the rigor of post-secondary biomedical sciences training.

The biomedical sciences comprise one of the largest industries in the United States, employing more than 15 million people working in a wide range of occupations. Over 10% of the national employment is in the healthcare industry. By the year 2014, over 3.6 million new healthcare jobs are expected to be created. Eight of the twenty occupations projected to have the greatest job growth over the next ten years are in healthcare. (U.S. Dept. of Labor, Bureau of Labor Statistics, 2006) Most people commonly think of healthcare in terms of hospitals, doctors, nurses, and dentists, but the biomedical sciences are much more varied and extensive. In addition to people who provide direct care and diagnostic services, the field includes those who do biomedical engineering, research disease and human physiology, study nutritional science, are involved in a variety of supporting professions such as, facilities design and management, environmental health and safety, health information management and analysis, industrial hygiene, and those who determine public policy affecting health care delivery, finance, regulation, and community services. Pharmaceutical manufacturing is the fastest growing manufacturing industry in the U.S. and requires workers to research, develop, manufacture, and supply medicines and other biomedical therapies derived from biotechnology. The United States is the world's leading developer and producer of modern medicines, and pharmaceuticals are an important American export.

Better understanding the role of the biomedical sciences in the modern world, as well as preparing for a career in this rapidly growing field, requires a broad foundation in science, mathematics, language arts, and social studies. Specialized knowledge is increasingly essential in such areas as genetics, biochemistry, microbiology, physiology, and public health, in addition to an awareness of the social, legal, and ethical issues surrounding technological advances related to the biomedical sciences.

Mission

We will create dynamic partnerships with our nation's schools to prepare an increasing and more diverse group of students to become more successful in the study of the biomedical sciences at the post-secondary level.

Goals

The proposed PLTW™ Biomedical Sciences program is intended to assist students in mastering the academic knowledge and necessary skills to succeed at the post-secondary education level and in any related career.

The PLTW™ Biomedical Sciences program will:

- Engage students in learning rigorous academic and technical knowledge
- Raise student achievement in science, mathematics, English language arts, and social studies
- Improve readiness for college
- Increase the number of students completing post-secondary degrees

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- Increase the number of students selecting careers in the biomedical sciences

The Sequence of Courses

Project Lead The Way, Inc. has agreed to develop the curriculum for a rigorous sequence of four core courses in the Biomedical Sciences. These are:

Principles of the Biomedical Sciences (1 Carnegie Unit)

This course provides an introduction to the biomedical sciences through exciting “hands-on” projects and problems. Student work involves the study of human medicine, research processes and an introduction to bio-informatics. Students investigate the human body systems and various health conditions including heart disease, diabetes, sickle-cell disease, 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 including: homeostasis, metabolism, inheritance of traits, feedback systems, and defense against disease are embedded in the curriculum. Engineering principles including: the design process, feedback loops, fluid dynamics, and the relationship of structure to function are incorporated in the curriculum where appropriate. The course is designed to provide an overview of all the courses in the Biomedical Sciences program and to lay the scientific foundation necessary for student success in the subsequent courses.

Human Body Systems (1 Carnegie Unit)

The human body is a complex system requiring care and maintenance. This course will engage students in the study of basic human physiology, especially in relationship to human health. Students will use a variety of monitors to examine body systems (respiratory, circulatory, and nervous) at rest and under stress, and observe the interactions between the various body systems. Students will use LabView[®] software to design and build systems to monitor body functions.

Medical Intervention (1 Carnegie Unit)

Medical practice includes interventions to support humans in treating disease and maintaining health. Student projects will investigate various medical interventions that extend and improve quality of life, including gene therapy, pharmacology, surgery, prosthetics, rehabilitation, and supportive care. Students will study the design and development of various medical interventions including vascular stents, cochlear implants, and prosthetic limbs. They will review the history of organ transplants and

gene therapy, and read current scientific literature to be aware of cutting edge developments. Using 3-D imaging software and current scientific research students will design and build a model of a therapeutic protein.

Science Research (1 Carnegie Unit)

This capstone course gives student teams the opportunity to work with a mentor, identify a science research topic, conduct research, write a scientific paper, and defend team conclusions and recommendations to a panel of outside reviewers. Each team will have one or more mentors from the scientific and/or medical community guiding their scientific research. This course may be combined with the capstone course from the pre-engineering pathway, allowing students from both pathways to work together to engineer a product that could impact healthcare.

While the coursework is intentionally rigorous with an emphasis on scientific principles and medical research, all students will be exposed to key concepts that will transfer to many fields. A student completing these courses will have the following attributes:

- Communicate effectively both orally and in writing
- Ability to think critically
- Practice professional conduct
- Ability to work in teams
- Understand how medical and scientific research is conducted and funded
- Understand the interdisciplinary nature of science, mathematics, English-language arts, and social studies

Teachers qualified to teach courses in this program must possess a minimum of a Bachelor's degree. College transcripts must include satisfactory completion of two semesters of general biology with a laboratory component. Preferably the teacher possesses a Bachelor's or Master's degree in Biology, Molecular Biology, Biochemistry, or Biomedical Science.

Strategic Plan:

Strategic Objective 1

By January 2005, the PLTW™ Curriculum Frameworks criteria and standards for Pre-Engineering will be reviewed, revised as necessary, and applied to the development and revision of all Biomedical Sciences instructional materials.

Strategic Objective 2

By 2012, 100% of students completing the PLTW™ Biomedical Sciences program will meet college entrance requirements for post-secondary study in the Biomedical Sciences; of those students at least 90% will successfully complete

their first year of further study and at least 75% will graduate from two- or four-year college programs.

Strategic Objective 3

By 2012, at least 1000 schools will be in the PLTW™ Biomedical Sciences program, and university affiliates will be geographically distributed across the nation.

Strategic Objective 4

By 2015, the number of high school graduates completing the PLTW™ Biomedical Sciences program who are accepted in post-secondary biomedical science programs will increase by 20% compared to the number accepted in 2012.

Strategic Objective 5

By 2013, the enrollment of males in PLTW™ Biomedical Sciences courses will be 10% higher than the current national enrollment of males in comparable high school programs.

Strategic Objective 6

By 2013 the racial and ethnic minority student population enrolled in PLTW™ Biomedical Sciences courses within a state will be collectively proportionate to that state's overall population.

Strategic Objective 7

By the end of the second year of membership in the PLTW™ Biomedical Sciences program, each school will have an effective school partnership team for biomedical sciences consisting of local business, medical, and community members.

Program Attributes:

A curriculum in the Biomedical Sciences developed by PLTW will have the following attributes:

- Mirror the PLTW™ Pre-Engineering program model.
- Offer a minimum of four (4) high school courses.
- Require students enrolled in the PLTW™ Biomedical Sciences program to complete a Biology course by the end of grade 10, and an Algebra I course by the end of grade 9.
- Assure that students are enrolled in four years of college-preparatory mathematics and science courses.
- Permit the PLTW™ Biotechnical Engineering course to be an elective in schools offering both the PLTW™ Pre-Engineering and Biomedical Sciences programs.

- Structure all courses as project- and problem-based learning opportunities which meaningfully integrate science, mathematics, English-language arts, and social studies.
- Assure that all courses are developed following the PLTW™ Curriculum Frameworks, which requires alignment with appropriate national learning standards, and assurances of rigor and relevance across numerous attributes.
- Assure that reading and writing learning and application expectations are rigorous and consistent with accepted scientific and/or medical literature.
- Design all courses to be universally relevant to biomedical sciences and not directed to a single career focus.
- Assure that professional development for teachers and school counselors models the PLTW™ Pre-Engineering program.
- Provide support for school implementation by modeling the existing PLTW™ Pre-Engineering program for purchasing, technical assistance, school certification, college credit, and ongoing professional development.

Timeline and Milestones:

2005-07

- Assure that funding for the entire project has been committed.
- Hire appropriate additional staff.
- Create a National Advisory Board for Biomedical Sciences.
- Develop curriculum for the first course to be field tested in 2007-08.
- Establish protocols for school participation, teacher professional development, and course evaluation in the Biomedical Sciences program, using the Pre-Engineering protocols as models.
- Identify teachers and college professors to work on the development of the second, third and fourth courses.
- Establish a marketing plan for the program with continuous improvement over time.
- Establish program evaluation strategies for continuous improvement over time.

2007-08

- Field test the first course in states that provided funding for course development.
- Revise the first course using feedback from the field test.
- Develop curriculum for the second course to be field tested in 2008-09.
- Identify high school teachers and college professors to work on the development of the third and fourth courses.

2008-09

- Publish the first course nationwide.
- Field test the second course in states that provided funding for course development.
- Revise the second course using feedback from the field test.
- Develop curriculum for the third course to be field tested in 2009-2010.

2009-10

- Publish the second course nationwide.
- Field test the third course in states that provided funding for course development.
- Revise the third course using feedback from the field test.
- Develop curriculum for the fourth course to be field tested in 2010-2011.

2010-11

- Publish the third course nationwide.
- Field test the fourth course in states that provided funding for course development.
- Revise the fourth course using feedback from the field test.

2011-12

- Publish the fourth course nationwide.