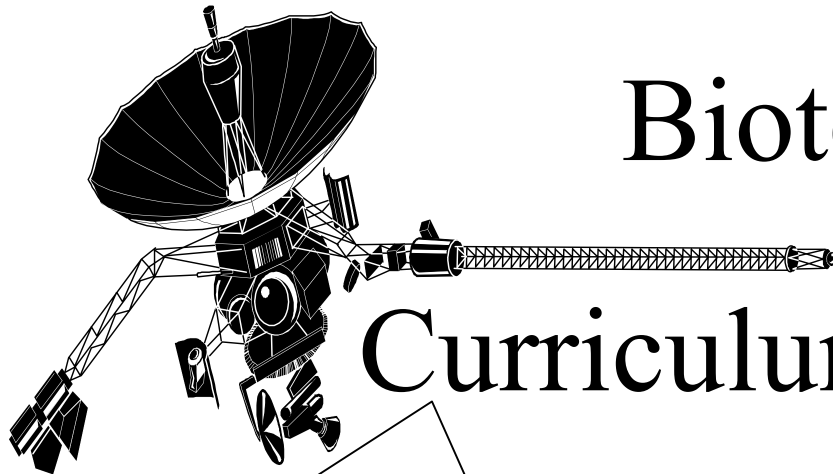

Biotechnology Curriculum Framework

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Pennsylvania Department of Education
Bureau of Curriculum and Academic Services
Bureau of Vocational-Technical Education

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A Biotechnology Curriculum Framework

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF EDUCATION
333 MARKET STREET
HARRISBURG, PA 17126-0333

January 2002

Dear Educator:

Pennsylvania is committed to our greatest national resource, our children. Our children must be able to leave our schools with the ability to face the challenges in today's increasingly complex world. For this reason, we must challenge our children to learn at higher levels than ever before. The academic standards are a critical step to meeting that challenge.

Pennsylvania's academic standards define what a student should know and be able to do at a specified grade level. The Academic Standards for Science and Technology and Environment and Ecology are both innovative and exciting. The biotechnology component of the standards is extensive and unique in that no other state has attempted to integrate science, technology, and agriculture through biotechnology. The study of biotechnology invites both teachers and students to use new technology and modifications of past technologies to meet multiple academic standards.

The ***Biotechnology Curriculum Framework*** is centered around the convictions that:

- all children can learn biotechnology
- diversity and innovation enriches all classrooms
- there is a body of knowledge in biotechnology that is important for all students to know, and
- there are processes of learning and habits of mind, which can be learned through biotechnology, that will help students develop higher-order thinking and problem-solving skills and that will be of lifelong use to students in their economic, civic, and personal lives.

I hope that the ***Biotechnology Curriculum Framework***, which has as its goal the lifelong achievement and well being of Pennsylvania students, will be a useful resource in meeting the Proposed Academic Standards for Science and Technology and Environment and Ecology.

Sincerely yours,

Charles B. Zogby
Secretary of Education

Foreword

The impetus for this project came from the keen insight of Mr. Robert Dorn, Technology Education Advisor, and Dr. G. Kip Bollinger, Science Education Advisor. They realized that many of Pennsylvania's educators might be intimidated by the inclusion of biotechnology in the Academic Standards for Science and Technology and Environment and Ecology. A desire to make the classroom implementation of these standards as easy as possible sparked the creation of the ***Biotechnology Curriculum Framework.*** Because biotechnology should encompass agriculture as well as science and technology, Mr. Timothy Weller, Agriculture Education Advisor, joined the project.

The first task was to establish some commonality between the disciplines (Strands) of Agriculture, Science and Technology Education. The following strand advisors were identified: Agriculture – Thomas O. Oyler, Jr., Pennsylvania Department of Agriculture; Science – Dr. G. Kip Bollinger, Pennsylvania Department of Education; and Dr. Ernest N. Savage, Bowling Green University. In November of 1998 these advisors and the advisors from the Pennsylvania Department of Education met to establish common ground for the development of the individual subject frameworks. It was at that meeting that the "Content Organizers" of Agriculture, Bio-Materials, Genetic Engineering, Medical Technology, Regulations and Safety and Resource Recovery were established.

Interns from the State System of Higher Education provided critical support and perspectives on this project. In January of 1999, Ms. Kimberly Rivera, Indiana University, helped initiate the work and establish the overall project purpose and goals. Mr. Michael Plyler, Edinboro University, entered in January 2000, to continue coordinating and organizing the project for efficiency. Mr. John Benson, East Stroudsburg University, provided final editing and prepublication work. Together, these three interns provided tremendous effort, intelligence and persistence. Without their enthusiastic support this project would not have been possible.

During the last week of February 1999, the advisory team convened for the initial writing meeting. Among those in attendance were educators, school administrators, industry representatives, parents and Department of Education representatives. At this meeting, the framework was outlined and the committee members began to develop content areas and activities appropriate to the standards. This work was continued at a second meeting in April of 1999. Regional meetings were held that summer to identify commonalities among the three subject strands. Throughout the next several months, the Pennsylvania Department of Education staff and the advisory committee members worked on refining the framework and integrating activities among the three subjects.

A third committee meeting was held in March of 2000. The matrix was finalized, lesson activities were completed, and the planning for piloting of selected activities at various school locations was completed. Piloting was performed during the months of March and April by teachers from across the state, in several disciplines, and at grade levels from kindergarten through twelfth grade. Feedback from the piloting was integrated into the activities in preparation for the final committee meeting in October, 2000. At that time final editing of activities and frameworks was accomplished, the integration matrix was created and the first draft of the ***Biotechnology Curriculum Framework*** was completed.

The project coodinators of this project would like to thank all of the people involved for giving the best that they had. Their hard work and dedication to this project have led to our nation's first ***Biotechnology Curriculum Framework.***

Preface

Biotechnology is an exciting and rapidly changing field. Its applications are so broad and the advantages to society are so compelling that virtually every industry currently uses biotechnology in some form. Through advances in biotechnology we have improved plant resistance to pests, disease, and drought conditions and altered the way we produce food and cooking agents. We have improved sewage and organic waste treatment processes. We have also developed tissue engineering for the replacement of organs and altered gene therapy. These are just a few examples of the way biotechnology is impacting our lives.[1]

Biotechnology is a high technology industry that employs specially trained personnel. It allows us to use leading edge research and development and also to compete for careers in these developing fields. The past several years have seen a dramatic increase in our knowledge of nature and natural processes. Biotechnology allows us to make new or better products with greater speed, efficiency and flexibility.

To ensure that Pennsylvania's students are prepared for the future, it is essential that we teach them about biotechnology. Not only will the biotechnological advances impact the way we teach and the way we live, it will also impact the job market our students will be competing in. We must prepare our children for the future implications of biotechnology, and that preparation should begin now.

The ***Biotechnology Curriculum Framework*** is offered as a curriculum resource to all Pennsylvania teachers, schools and school districts to assist them in their quest to meet the Proposed Academic Standards for Science and Technology and Environment and Ecology. The goal of this curriculum framework is to provide assistance to educators in meeting the biotechnology portion of the standards. It provides clear examples of appropriate content, as well as sample lessons and activities that can be taught to meet the Proposed Science and Technology and Environment and Ecology Standards.

This framework is intended to be a guide and serve as a basis for further research and investigation. Educators are encouraged to look outside of the ***Biotechnology Curriculum Framework*** for instances of biotechnology and their relevance to the classroom. The inclusion of sample lessons, book titles, publishers and organization names do not constitute an endorsement or recommendation by the Pennsylvania Department of Education. This information is included as a service to the educational community.

[1] What is Biotechnology. The University of South Wales, Sydney Australia

WHAT IS BIOTECHNOLOGY?

What does it mean for us today?

The word biotechnology itself is quite simple to understand. Bio represents biology, which is the science of all living things. Technology represents the tools and techniques used to apply our knowledge so that living organisms respond as we want them to. The interpretation of what biotechnology is can be very broad; for example, a wooden chair is an example of biotechnology since it originated as a living organism. The interpretation could be very narrow, only those things that are living can be thought of as biotechnology. As far as this project is concerned, it was decided to develop a definition that fell somewhere in between: "Biotechnology is anything that directly effects or alters a living organism."

The discovery basic to modern biotechnology was that DNA is the same chemical structure in all living things. It is the expression of this DNA instruction book, which makes the differences in organisms. All cells use the same genetic language. And we have learned now how DNA can be moved from organism to organism, past natural barriers. It is at this level of biotechnology that we must consider the risks and challenges that are involved. Earlier, biotechnology included plant and animal breeding/hybridizing. But there was never a venture outside the genetic structure of the organisms.

The 1999 July/August issue of WorldWatch carries an article clearly outlining the need for doubling the world's food supply - yet addressing the transgenic seeds' (all patented) impact on the natural environment and its diversity. Today's biotechnological power brings the value of risk assessment, critical thinking and decision-making, all processes we hope to impart to our students. One major area of concern exists in decision-making. International foci push for decision-making in the area of crop production. With six billion people in the world, there is a need for food. Improving crops is essential. But what are the risks involved? The recent chemical industry developments of pesticide and herbicide resistant plants, as well as "terminator" seed plants, has caused broad concern about their increasing use. These are salient and useful issues for student consideration.

Educators need to ask their students not only "What do you know?", but "How do you know that?" Experimental science is a different way of knowing. But this goes beyond a demonstration, according to Thomas M. Zinnen (www.gene.com/ae/AB/IE/Gen395.htm "No Trick More Enlightening: Making Every demonstration an Experiment"). He stresses the value of controls and going beyond activity workshops such as extracting DNA. Following a protocol, he states, doesn't help the student conclude anything. There is a need for skepticism. "How do I know this contains some DNA? Might it also contain carbohydrate? Protein? What experiments can I do to test these ideas?" The demonstration, he reasons, sets the teacher up as the authority. The other way tells the student that there are valid ways of knowing...the "difference between knowing just the conclusions, and knowing how people can design experiments that generate the evidence that test the ideas".

Pilot Activities of the Biotechnology Curriculum Framework

An integral step in the development of the Biotechnology Curriculum Framework was the piloting of selected activities at various schools throughout the state. After the final meeting of the advisory teams in March of 2000, about 45 schools were asked to teach Biotechnology Learning Activities that are contained in this framework. The Department of Education selected the lessons appropriate to the subject and grade level taught by the volunteer teachers.

A pilot site coordinator, who in many cases was the classroom teacher, represented each school or school district. That person was responsible for dispersing materials and resources needed to teach the activity. The teacher was given the option to use materials provided by the Department of Education or to use their own. A stipend was made available to the teachers to offset costs they incurred to complete the activity.

By the end of April 2000, a cross section of activities which represented each content area of Agriculture, Bio-Materials, Genetic Engineering, Medical Technology, Regulation and Safety and Resource Recovery, under the subject strands of Science, Agriculture, and Technology Education had been completed in the classroom. Each grade level was represented at least once throughout this process. The teacher or site coordinator reported to the Department of Education via an evaluation rubric that spelled out deficiencies or strengths and weaknesses in the framework. The department then edited the framework, removing or revising activities that did not meet the standards successfully.

We, at the Department of Education, are very pleased that the Biotechnology Curriculum Framework includes the expert input of the professionals for which it is intended.

Introduction to the Biotechnology Curriculum Framework for Agriculture Education

Did you ever wonder about the usefulness of worms? Or maybe you are curious about how plants can grow in water (hydroponics) when you were always taught that they needed soil to grow. Do farmers have the answer to our world hunger problem? This handbook will help you and your students answer these and many more questions.

Over the past thirty months a diverse group of educators, industry representatives, policymakers and others who share a common vision for an agriculture-oriented approach to teaching biotechnology concepts and practices met to develop the materials that are included in this handbook.

This committee created a series of biotechnology learning activities presented in a lesson plan format. These activities are designed around six strands and are directly related to the content and skills associated with the Pennsylvania Proposed Academic Standards for Science and Technology and Environment and Ecology. The six strands are threaded across the three areas (Agriculture Education, Science Education, and Technology Education) in the comprehensive Biotechnology Curriculum Framework. The strands include 1) agriculture, 2) bio-materials, 3) genetic engineering, 4) medical technology, 5) regulations and safety, and 6) resource recovery. A quick review of the lesson plan format would indicate that the activities are written in a teacher-friendly, student-centered manner.

The purpose of this project is to put ready-to-use, standards-based lessons in the hands of all educators. These lessons are developed with the intent of promoting an interdisciplinary, K-12 approach to helping students learn about current, real-life agricultural biotechnology issues and solutions. For example, issues such as what to do with garbage or how to grow crops in an environmentally responsible way are addressed. Central to this entire endeavor is the most important fact that the economic viability of farming is contingent upon an educated population.

These lessons are a good resource for the classroom teacher, but their use should be planned in the context of the overall curriculum. You can easily integrate reading, writing, research, math and technology content and skills into these lessons. As your school works to implement a standards-based educational program, these resources should be very helpful in engaging your students in a study of agriculture that is essential to their understanding of how we need to work together to insure an adequate and safe food supply.

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