

AC 2007-2921: INTRODUCING BIOTECHNOLOGY MANUFACTURING THROUGH ELECTIVES

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Introducing Biotechnology Manufacturing Through Electives

Abstract – The Technology Department at Alabama A&M University (AAMU) is developing courses for a Biotechnology Manufacturing elective area. The biotechnology field has much promise to grow rapidly in the region and nation. Huntsville, Alabama, is on its way to becoming a leader in the biotechnology industry with the construction of the Hudson-Alpha Institute for Biotechnology (HAIB) in Huntsville. The institute will contain state-of-the-art laboratories for biotechnology and is expected to attract many new industries to the area. The institute is expected to employ some 400 scientists and staff when it opens in mid-2007. The Technology Department at AAMU has developed several new courses to better equip graduates with the knowledge and skills to design, maintain, and operate biotechnology devices (or systems). The primary objective of the Biotechnology Manufacturing elective area will be to produce graduates that will have the knowledge in biogenetics and up-to-date technology to support this industry efficiently. This paper will discuss some of the essential elements of courses to support Biotechnology Manufacturing.

Keywords: Hudson-Alpha Institute for Biotechnology (HAIB), Biotechnology Manufacturing.

Introduction

Huntsville, Alabama, is one of the best-known “high-tech” cities in the nation with the highest per capita income in the Southeast [1]. As “America’s space capital,” technology, space, and defense industries have a major presence here with the Army's Redstone Arsenal, NASA's Marshall Space Flight Center, and Cummings Research Park. However, in the near future, Huntsville will not be only known for its space and defense industries; it will also be known as one of the important biotechnology cities in the nation. This is all because of biotechnology pioneer Jim Hudson’s vision of creating an institute – Hudson-Alpha Institute for Biotechnology (HAIB).

In August 2005, Alabama officials formally announced the location of the Hudson-Alpha Institute for Biotechnology (HAIB) in Cummings Research Park (CRP) in Huntsville, Alabama, and the creation of a 120-acre biotechnology site to be named the CRP Biotech Campus. When completed in mid-2007, the HAIB will be the second-largest biotechnology institute located on the second-largest biotechnology campus in the nation [2]. The institute will contain state-of-the-art laboratories for biotechnology and is expected to employ some 400 scientists and staff upon opening. According to Jim Hudson, institute founder and president, the institute is expected to employ 900 at full capacity. The property, sold by the City of Huntsville, is large enough to accommodate new buildings for companies that outgrow their space in the institute. Hudson estimates that the overall campus could employ 1,600 within ten years with an annual payroll of \$83 million [3]. The institute has recruited eight biotech companies, many with previous affiliations with Hudson and based in Huntsville, to move into the facility: Applied Genomics, Expression Genetics, Genaco Biomedical Products, New Century Pharmaceuticals, Open Biosystems, Operon Biotechnologies, SourceCF, and Nektar Therapeutics [4].

Biotechnology Manufacturing

In the early 1950s, after a group of German rocket scientists came to Redstone Arsenal to develop rockets for the United States Army, Huntsville became one of the leading technological cities in the nation. Many Fortune 500 companies have had their presence in the Huntsville area since then. Experts predict that the same thing will happen with the completion of the HAIB; Huntsville will attract many biotechnology companies and pharmaceutical companies to the city. The demand of employees in biotechnology industry will dramatically increase. Since the majority of the biotech companies are depending on profiting from the manufacturing of genetics products and not from research and development, employees with manufacturing skills will be in high demand. More than 90% of the jobs will be production-related while only 7% will be in research and development [5]. Companies are not looking for scientists; they are looking for people who know how to design, maintain, or operate biotechnology devices (or systems). Currently in north Alabama, there is only one institute, University of Alabama in Huntsville (UAH), offering a biotechnology degree at the graduate level which will produce research scientists [6]. There are no institutions in or around the city of Huntsville offering an undergraduate degree in biotechnology. Based on the expected future market demand, the Technology Department sees the opportunity to develop a Biotechnology Manufacturing program.

Biotechnology Manufacturing Courses

The process of development and approval of a new degree program in Biotechnology Manufacturing would be very lengthy and require approval at many levels through the university and state government. The department has chosen to rather develop elective course to be made available to EET and MET students. The success of these elective courses could then lead to a concentration or new degree program.

To develop appropriate courses, we have studied the curriculum of the biotechnology manufacturing certification program at the Springfield Technical Community College (STCC) because of its location in Massachusetts, which currently has the highest concentration of biotechnology activity in the world [7]. The majority of the courses under the biotechnology manufacturing certification program at STCC are already covered under our EET program. Courses not in our EET curriculum are covered in other departments' curriculums. Table 1 shows the three of courses at STCC not currently covered at AAMU. The Technology Department developed new courses to cover the missing subjects. After consulting with several professionals from the local biotechnology companies, the following elective courses were developed for Biotechnology Manufacturing:

Elective Course 1

DNA Science – This course provides students with basic knowledge in DNA science and covers the classical genetics and DNA structure. The course explains the theory behind methods used in the laboratory sequence. Advanced techniques for analyzing complex genomes will be discussed, and recombinant DNA in science will also be introduced.

Elective Course 2

Biotechnology – This course provides students with information concerning biotechnology. It explains and discusses each research and production technique or protocol commonly used within the biotechnology industry. The course also demonstrates how to apply robotic engineering technology to implement these techniques or protocols. Students will become familiar with many electronic technologies incorporated into biotechnology manufacturing processes. Field trips to local biotechnology companies will enable students to have a real-life experience with the operations in the field of biotechnology.

Elective Course 3

Safety/Quality Control for Biotechnology Manufacturing – This course covers the National Institute of Health’s (NIH) guidelines, alternative procedures for the handling and disposal of laboratory waste, and the United States Food & Drug Administration’s (USFDA) regulatory requirements. Topics also include the Good Manufacturing Practice (GMP) regulations, requirements for buildings, facilities, equipments, and control systems used in production and laboratories.

Elective Course 4

Biotechnology Manufacturing Laboratory - This laboratory exercise will train students using biotechnology-manufacturing equipments donated by the local biotechnology companies. Students will learn how to operate and monitor these equipments and how to document the process. Maintenance, troubleshooting, and problem solving are also part of the course.

Table 1. Biotechnology Manufacturing courses at STCC and courses offered at AAMU

STCC Course Name	AAMU Course Name (Department)
Principles of Biology 1	BIO 103 (Biology)
Microbiology	BIO 330 (Biology)
Principles of Refrigeration	MET 407 (Technology)
Materials and Processing for World-Class Manufacturing	N/A
Quality Control for Biotechnology Manufacturing	N/A
Biotechnology	N/A

Development of Biotechnology Manufacturing Concentration in EET

The proposed Biotechnology Manufacturing courses are designed work within the core of the EET program. Majoring in this elective area would only require making some minor adjustments to the regular EET curriculum. In their freshman year, students wishing to specialize in Biotechnology Manufacturing would take “Principles of Biology 1” (Bio 103 & Bio 103L) instead of a fine arts elective. During their sophomore year, students would take elective course 1 (DNA Science) and elective course 3 (Safety/Quality Control for Biotechnology Manufacturing) as their technical electives. In their junior year, they would replace “Natural/Physical Science w/Lab” with “Microbiology” (Bio 330 & Bio 330L). Also, they would take “Fundamentals of Heating, Ventilation, and Air Conditioning” (MET 407) as their EET elective.

During their senior year, students would be required to take elective course 2 (Biotechnology) and elective course 4 (Biotechnology Manufacturing Laboratory) as their EET electives. In their “Capstone Design Phase I and II” (EET 428 & EET 429), students would be required to do their project in the area of Biotechnology Manufacturing or find an internship with a local biotechnology company in order to gain practical experience. Students selecting the project will be evaluated by a professional from a local biotechnology industry. Students doing the internship will be evaluated by their industrial supervisor.

Conclusion

The construction of Hudson-Alpha Institute for Biotechnology will make Huntsville one of the most important biotechnology communities in the world. Many biotechnology companies and pharmaceutical companies are expected to move into the area in the near future. The demand for a well-trained and technologically skilled workforce in biotechnology manufacturing is expected to be high. The Technology Department in AAMU will take part in this revolution by offering a Biotechnology Manufacturing elective area within the Engineering Technology program. By adding four new courses as electives, and proper use of other electives, students in the Engineering Technology can become prepared for careers in Biotechnology Manufacturing.

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