Curriculum-Based Biomaterials Education for Secondary Students

Lisa C. Benson and Karen J. L. Burg
Clemson University, Clemson, South Carolina

Introduction: A series of curriculum-based hands-on activities for high school students was developed that provided contextual examples of cell-biomaterial interactions and polymer science. This series was offered in conjunction with a national professional meeting, and may be used as a template for other similarly themed activities. The goal is to introduce biomaterials in existing secondary science courses, to enhance required topics and introduce students to the field of biomaterials. College students who lead such activities also benefit by putting their research into a broader context.

Methods: An outreach activity was conducted at the annual meeting of the National Society for Histotechnology in Phoenix, Arizona for 130 high school students from 5 area schools. Students were given background information on histotechnology, biomaterials and cell-biomaterials interactions. They examined histological slides that displayed healthy tissue and diseased tissue, or tissue with an embedded implant (for example, a healthy artery and an artery with a metal stent). A handout was prepared with images and descriptions of cells typically observed around a biomaterial. The handout also included information on polymer science, and applications of absorbable polymers. Students prepared their own histological sections from paraffin-embedded muscle tissue containing an absorbable (polylactide) suture. Microtomes, staining stations and microscopes were made available to students by vendors at the meeting. Samples of materials such as collagen, silicone, and polyethylene, as well as implants made from these materials, were provided and overviewed by bioengineering graduate students. Applications for biomaterials in tissue engineered implants were also highlighted. Histotechnologists lead students through the technical exhibits and, along with the exhibit vendors, helped explain the significance of what the students were observing.

The teachers accompanying the students were given materials that identified specific curriculum standards that were addressed through the activities. The relevant National Science Education Standards that were addressed with these activities include:

1. Inquiry (NS.9-12.1; Abilities needed to do scientific inquiry; Understandings about scientific inquiry)
2. Physical Science (NS.9-12.2; Structure of atoms; Structure/properties of matter; Chemical reactions)
3. Life Science (NS.9-12.3; The cell; Matter, energy, and organization in living systems)
4. Science and Technology (NS.9-12.5; Abilities of technological design; Understandings about science and technology)
5. Personal and Social Perspectives (NS.9-12.6; Personal and community health; Science and technology in local, national, and global challenges).

Discussion: Shrinking numbers of students in science, technology, engineering and math (STEM) disciplines in the U.S (NSB 2006) have resulted in a short supply of qualified personnel pursuing careers in high-demand areas in the sciences and engineering. This activity enabled professionals and college students at a technical conference to demonstrate the value of education and careers in science and engineering within the context of real-life applications. Participating teachers indicated that the energy associated with a technical conference increased their students' interest, and broadened their understanding of how the science topics that they learn in school are applied in the real world. By observing professionals discussing scientific topics with each other, and by directly asking questions of the professionals, students gained a new perspective of potential education and career paths in science and engineering. The students gained an appreciation for the complexity of the body's reactions to a foreign material and the need for advances in tissue engineering, and were able to view themselves as potential problem-solvers in the healthcare industry.

This approach may be used for local and regional technical meetings as well as national conferences, particularly ones including technical exhibits by local or regional vendors. Components of a successful outreach program at a technical meeting include 1) well-organized hands-on activities that engage students in a critical aspect of the technical field; 2) printed materials that identify and explain science or math concepts that are applied in the activity; 3) guided tours through the technical exhibit, allotting enough time for students to explore displays and converse with vendors; 4) teacher guides with suggested classroom follow-up activities, that identify curriculum standards addressed through these activities. Other important components of a day-long outreach program are 20 – 30 volunteers (either college students or members of the professional organization hosting the conference), and financial support. Private organizations and companies are typically willing to support effective outreach programs, either through monetary support or the donation of technical equipment or personnel, as a way to invest in their future workforce.

Conclusions: Curriculum-based activities delivered at a technical conference are effective at engaging students in science-related topics, and provide a valuable means to introduce complex topics such as biomaterials and tissue engineering into secondary science education.

References: National Science Board (NSB) 2006. "Science and Engineering Indicators 2006," Vol 1, NSB 06-01; Vol 2, NSB 06-01A. National Science Foundation, Arlington, VA; http://www.nsf.gov/statistics/seind06; Gross, PR. 2005. "The State of State Science Standards," Thomas B. Fordham Foundation, Washington, DC.

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