

## Editorial

# Are Graduate Programs Training Pharmaceutical Scientists to Function Effectively in the New, Highly Integrated and Globalized Pharmaceutical Industry?

In the past 10–15 years, the pharmaceutical industry has undergone dramatic changes. It was once dominated by fully integrated pharmaceutical companies (FIPCOs), which manufactured and marketed their products worldwide, but tended to conduct their discovery research and product development activities in a fragmented way at a limited number of sites within their home countries. Today, because of the mergers and acquisitions in this industry, we have fewer but larger FIPCOs, which conduct their discovery research and product development at multiple sites around the world in a highly integrated manner.

The pharmaceutical industry, at least in the United States, has also been impacted by the emergence of small drug discovery companies funded with venture capital. This trend was begun in the United States by biotechnology companies. However, more recently, small companies have been set up to take advantage of new technologies such as combinatorial chemistry and gene sequencing. Initially, many of these companies strived to become FIPCOs. However, many of these companies now tend to follow the strategy of focusing on their strength, which is discovery research, and developing strategic alliances with FIPCOs in order to gain the financial resources necessary to carry their drug candidates through preclinical and clinical development. These strategic alliances require that scientists in the small drug discovery companies integrate their activities with those of scientists in FIPCOs. Again, this integration is often global in nature.

The pharmaceutical industry has also seen the emergence of boutique technology companies, which have highly specialized technologies (e.g., drug delivery systems) that can be licensed to FIPCOs to facilitate development of their drug candidates. Like small drug discovery companies, these boutique technology companies need to closely integrate the development of their technologies with those of FIPCOs; this often involves global interactions.

Finally, in the past 10–15 years the pharmaceutical industry has also seen the emergence of contract research organizations (CROs). These CROs service a broad spectrum of pharmaceutical companies, including FIPCOs as well as small drug discovery and boutique technology companies. A CRO based in the United States could be conducting development work for a Japanese pharmaceutical company that wishes to register its product in Europe. Thus, integration and globalization are also impacting this sector of the industry.

These changes in the pharmaceutical industry pose interesting questions for the academic community. Are graduate programs preparing pharmaceutical scientists to work in this highly integrated and globalized industry? If not, what activities and/or experiences do we need to incorporate into our graduate

programs so that our students are better prepared to make significant contributions to their future employers and to have successful professional careers?

From a scientific perspective, I think it is no longer sufficient for a graduate student to simply become the world's expert on a very narrowly focused scientific issue. While depth of experiences in a particular area of the pharmaceutical sciences is still THE MOST IMPORTANT part of graduate education, we also need to provide our students with some breadth in their educational experiences so that they can function in the highly integrated activities that are now part of drug discovery and development. Increased breadth can often be achieved through the careful selection of graduate courses. For example, pharmaceuticals students planning future work on protein formulation in a biotechnology company should have a course in molecular biology so that they can effectively communicate with scientists in the company who clone and overexpress the proteins they are assigned to formulate.

Graduate students must also be given the opportunity to perform as part of a team or to observe how a team functions because, while individual accomplishments are still important in the pharmaceutical industry, teamwork is crucial to the successful discovery and development of drugs. This exposure to teamwork can be accomplished within the university by having the student participate in a multidisciplinary research project. Alternatively, by taking part in an industrial internship program, the student could be exposed to teamwork in the pharmaceutical industry itself.

To function effectively in this new, highly integrated, team-oriented industry, graduate students need to develop excellent written and verbal communication skills. In addition, they need to have the ability to access and manipulate the explosion of new information. Graduate programs should make every effort possible to provide students with access to computers and computing networks and to train them in making effective use of this technology to become better scientists.

As the process of drug discovery and development becomes more integrated and team-oriented, management expects to reduce the time and thus the costs associated with discovery and development of new drugs. With these expectations come the pressures that often lead scientists to participate in unethical practices. Graduate programs should expose students, through formal courses and/or informal discussions, to ethical issues that they may encounter in the conduct of their future professional activities.

With respect to the recent globalization of the pharmaceutical industry, in my opinion, most graduate programs fail to adequately prepare pharmaceutical scientists to deal with the challenges associated with this new mode of operation. Often,

the challenges are not simply scientific, since science itself has been globalized for decades. Instead, the challenges are more social and cultural in nature. I think that many pharmaceutical companies have found that social and cultural issues rather than scientific issues become the major hurdles to effective globalization of drug discovery and development. For pharmaceutical scientists to function in this globalized industry, they need to be sensitive to social and cultural topics. This sensitivity can only come if the individuals have had "life experiences" that permit them to understand the underlying issues.

The big question then becomes, whose responsibility is it to prepare pharmaceutical scientists from a social and cultural perspective to function in this globalized industry? In some respects, preparation for this globalized environment should have started long before an individual enters a graduate program in the pharmaceutical sciences. An individual's home environment, as well as his/her primary, secondary and tertiary educational experiences, should all contribute to development in this area. However, graduate programs can also contribute to the ability of an individual to deal with the social and cultural aspects of globalization. For example, in the past, graduate students were exposed to the international scene primarily through contacts with international lecturers who visited the students' universities. However, these visits often involve individual meetings with faculty, followed by a scientific seminar attended by faculty and students. Thus, students were only exposed to the science of the international visitor. Perhaps students should be given the opportunity for more personal interactions with international visitors so that they can learn more about social and cultural issues. Other possible ways of increasing student exposure to the international scene include: (i) increasing the number of international Visiting Scientists, faculty and students within a graduate program; (ii) creating opportunities for students to attend international meetings; and (iii) creating opportunities for students to have extended stays

at international universities or companies to conduct part of their dissertation research. All of these types of interactions will contribute to the "life experiences" of the students and will better prepare them to function in the new, globalized pharmaceutical industry.

In conclusion, I would like to encourage all those persons involved in graduate programs in the pharmaceutical sciences to address the following question: "Is your graduate program training students to function effectively in the new, highly integrated and globalized pharmaceutical industry?" If your answer is no, I challenge you to develop activities and/or experiences for your students that will better prepare them for this environment. However, we must be careful that in the process of developing these new activities and/or experiences we *do not* sacrifice scientific excellence nor add to the time required for students to complete our graduate programs. Perhaps the responsibility to provide students with this broader perspective of science and society belongs in part to our professional organizations (*e.g.*, American Association of Pharmaceutical Scientists). The future success of our students is dependent upon our vision and our willingness to refine our programs to accommodate the significant changes in the pharmaceutical industry.

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*Editor's Note: Forthcoming issues will feature companion editorials on training graduate students to function effectively in the generic pharmaceutical industry and on nurturing junior pharmaceutical sciences faculty.*