Chair Report of the Research and Graduate Affairs Committee

Wayne Anderson

INTRODUCTION
President Charles O. Rutledge presented the following charges to the 1996-97 Research and Graduate Affairs Committee (RGAC):
• evaluate the role of the Master’s degree (MS) in the pharmaceutical sciences and determine whether the role should be diminished or expanded;
• evaluate the role of interdisciplinary research on graduate education in the pharmaceutical sciences; and
• examine the extent to which the principles of scientific investigation are incorporated into graduate programs in the pharmaceutical sciences.

The 1994-95 RGAC performed an “environmental scan” on the impact health care reform and the changes in the pharmaceutical industry had on research and graduate education in the pharmaceutical sciences(1). The 1995-96 RGAC updated this environmental scan and made a series of recommendations regarding the effect of changes in the pharmaceutical industry on the state of graduate education in the pharmaceutical sciences(2). During the same time period other national science organizations and publications examined and published reports on the state of the entire graduate education enterprise in the U.S.(3-5). This increase in interest on graduate education was primarily brought about by the perceived oversupply of PhD graduates for the available present and future research positions in academia and industry. In addition to the quantity of PhD students, the quality of the program leading to PhD degree was questioned. Among the resulting recommendations was the suggestion to broaden the educational program for the PhD degree; prepare candidates for nonacademic, nonresearch intensive industry positions as the majority of PhD graduates are employed in nonresearch activities(3).

ROLE OF THE MASTERS DEGREE IN THE PHARMACEUTICAL SCIENCES
Another recommendation that emerged from the debate on the quality and quantity of graduate education, was to re-evaluate the role of the master’s (MS) degree(4,5). Presently, the MS degree in the sciences, including the pharmaceutical sciences, is treated as an interim step on the way to the PhD degree. Students receive a MS degree through successful completion of the didactic portion of the PhD program (sometimes with a thesis), or alternatively, receive a MS degree when the student’s graduate advisor or committee decides that the student does not have the ability to continue on to successfully complete a PhD research project. Since the traditional MS in the sciences is treated as a predoctoral or pre-PhD degree, students in both the MS and PhD degree programs usually take the same didactic coursework, primarily theoretically oriented, to prepare for a research career. This predoctoral role of the traditional MS degree in the sciences negatively impacts a student who obtains an MS degree at one institution, and then immediately transfers to another institution to complete a PhD degree program. Unless the two institutions attended by the student have a prior agreement, the time invested in coursework and research for the MS degree in the first institution will have little impact on the time required to complete the PhD degree program in the second institution.

The predoctoral role of the MS degree in the sciences is in distinct contrast to the role of a master’s degree in other fields, such as business (MBA), education (MEd), and public health (MPH). These master’s degrees are viewed as significantly enhancing specific skills of recipients, often leading to opportunities for employment or advancement in areas which are generally denied to persons only holding a baccalaureate degree. The MBA degree, with its many specializations, is generally considered to be a terminal degree, but increasingly, persons with an professional degree (MD and PharmD) or a PhD degree are obtaining the MBA degree to increase their business and management skills(5,6).

The role of the MS degree as a predoctoral degree, appears to be changing because of increasing student interest in obtaining additional education/training in specific areas without a long-term commitment to a PhD program. The emergence of new MS degrees in the life sciences has occurred because of the explosion of biotechnology associated manufacturing processes and research in the pharmaceutical and agricultural industries. These industries

Committee members: Wayne Anderson, Chair (Buffalo); John A Bosso (MUSC); Gary L. Grunewald (Kansas); Jean C. Shih (Southern California); Kareem F.A. Soliman (Florida A&M); Joseph B. Wiederholt (Wisconsin-Madison)
have an increased demand for technically proficient employees for a variety of operations, manufacturing, and testing procedures and they provide satisfying career opportunities for persons with a MS degree(7). Another area of high demand for persons with specialized advanced skills is in the area of clinical research, particularly in the rapidly growing Contract Research Organizations (CROs) which are conducting clinical trials of new drugs for pharmaceutical and biotechnology companies(8).

EVALUATION AND REDESIGN OF THE MS DEGREE PROGRAM

The RGAC recommends that schools having or planning to offer MS degree programs consider the design or redesign of the MS degree program as a stand alone degree. This should include institutions which desire to continue to offer the MS degree as a predoctoral degree program. However, the requirements for obtaining the degree should be agreed upon by all faculty and be awarded only after successful completion of the degree program requirements, not as a “consolation” prize. If a student does not demonstrate potential for continuation and completion of a doctorate degree at the institution, they should not be admitted to the program. Using this model for the MS degree program in this model also provides the student with an opportunity to decide whether or not to proceed onto the doctorate degree at the same institution, or to transfer to another program or institution.

Another type of MS degree which is gaining increasing acceptance and is similar to the MBA, MPH and the MS (Hospital Pharmacy) is the applied science degree model, where an MS degree program provides individuals with specific skills and techniques, along with the theoretical foundation of those skills and techniques. Some of the required coursework in this new MS degree would be the same as that required for the PhD degree, but the emphasis of the didactic portion of the applied science MS degree program would be on information with applicability to problems in a specific area of study (business, biotechnology, etc.). The use of internships at potential employment sites would be important to demonstrate the applicability of the science concepts taught in the didactic portion of the program. Moreover, designing an MS degree program as an applied science degree could attract advanced degree professionals (MD, DDS, PharmD) and scientists (PhD) who want to enhance their employability or change career directions. It could also be offered to currently enrolled professional degree pharmacy students or those in another college or university program, so that a student could concurrently study for both degrees and complete both in one extra year of full-time study (i.e., BS/MS, PharmD/MS).

If a faculty decides to design a new MS degree program utilizing the applied science model, it is necessary that faculty identify, and continually update, the specific societal (i.e., patient, practice, industry) needs that are projected to be addressed by the program graduates. This can be accomplished by involving representatives of the potential employers in the development, teaching, and continued evaluation of the program. Employer involvement in the program may not only attract potential students, but may also provide student financial support, and sites for program internships. It should be emphasized that refocusing a new MS degree program on the application of science for more specific tasks does not eliminate the need for rigor and quality assurance. A continuous quality assurance mechanism (competency assessment) including feedback from program graduates is necessary to keep skill set and knowledge base appropriate for identified societal need. Continued success of any new program will be judged by the ability of the program graduates to competently perform the skills and techniques for which they are recruited and hired.

There might be some concern that an applied science focused MS degree might divert students away from PhD programs. While that possibility exists with some students, the applied science focus of a new MS program would expand the potential student pool to not only include BS graduates, but also students with advanced professional degrees (PharmD, MD, DDS), and those with a PhD. Additionally, an applied science MS degree program does not preclude MS degree students from proceeding onto the PhD at some future date(s). Some potential PhD students may be reluctant to pursue a PhD because they are not familiar with research and are hesitant in making a long-term commitment to pursue the PhD. Obtaining the MS degree followed by a work experience may encourage individuals to continue their education and pursue the PhD. Other students, who have an interest in pursuing a research career may not have obtained the prerequisite GPA as undergraduates or professional degree students for admission to a PhD program. An applied science MS degree program would allow them to demonstrate their academic, research and work capabilities.

It is important that faculty at those schools who are interested in exploring instituting new and unique master’s degrees programs using the applied science degree program model, first determine if there is a significant societal need for the specific skills proposed to be addressed in the new MS program. Potential students who are currently working in industries within close proximity to a university may need or wish to continue full-time employment. For this reason, careful consideration must be given to offering an MS degree at times and places more convenient for the students. Alternatively, a school could offer the didactic portion of the degree program using electronic technology, such as the Internet(9). New degree programs should not be added without considering its impact on existing academic programs. Therefore, the consideration to add or redefine an MS degree program should be done as part of an overall strategic plan for the school, and its impact on successful existing degree programs must be evaluated.

There are several currently existing applied science MS degree programs. An example of a pharmacy school MS degree program which fits the applied science model is Temple University’s Quality Assurance/Regulatory Affairs MS degree program(10). Over ninety percent of the enrollees are presently employed in the pharmaceutical industry and over 200 students are enrolled in courses each semester. The present success of the program, which was almost dropped several years ago, is credited in part to the formation of an industry steering committee, with members from the pharmaceutical industry and the institution. Faculty from the pharmaceutical industry are recruited to offer selective elective courses, and employees of the Food and Drug Administration provide seminars on regulatory issues. Courses are offered on weekends and weeknights to meet the schedules of the students.

In response to the growing need for clinical researchers, the Massachusetts General Hospital (MGH) is establishing an MS degree in Clinical Investigation for health care professionals, including physicians, physical and occupational therapists, nurses, and pharmacists(11). While the program is being funded by MGH the first year, the hospital is “seeking continued support from foundations and industry.” In addition to the applied science courses, the MGH program proposes to offer such courses as “Ethics and Social Responsibility in Clinical Investigations,” and “Regulatory Law and Health Policy.”

The financial cost to both the school and the students is a very important consideration in the decision to offer a stand alone MS degree program. Can the school provide financial assistance to MS students, particularly if the degree does not primarily lead into a PhD program? Would students be eligible for research support through a faculty member’s NIH grant? Master’s degree programs are traditionally tuition supported(3). Any program, no matter what the size, requires school resources, primarily in terms of faculty time and effort. Are these resources best utilized in a new degree program or in other programs and activities? This question must be seriously considered in the decision to add or modify an MS degree program. Finally, the RGAC strongly believed that the new MS degree program should not be started to support faculty research efforts or prepare for the institution for the initiation of a PhD program.
CONCLUSIONS

- Schools with MS degree programs which desire to continue to use the MS degree primarily as a predoctoral degree, should consider redesigning the MS as a stand alone degree with a prescribed set of didactic and research requirements for completion, with the degree granted upon the successful completion of those requirements.
- Schools considering an addition of a MS degree program using the applied science model, should assess the demand for the degree to serve a local, regional, or national societal (patient, practice, industry) unmet need.
- If a significant demand for an applied science type MS degree exists, the faculty curriculum planning committee should include members of the societal group which has a demonstrated need for program graduates.
- The applied science model MS curriculum should focus on transmitting the desired skills and knowledge of the graduates for application upon graduation.
- The cost to the school and potential students of initiating an applied science MS degree program must be seriously considered, as institutional or extramural support of MS degree programs may be unavailable.
- Program rigor and continuous quality control measures must be detailed during the development of program curriculum. An ongoing assessment of the employment and performance of the graduates should be conducted to determine program quality.
- Degree programs should not be added without administration and faculty consideration of its impact on the schools' strategic plan. A new program should not be added to accommodate a single faculty member or department.
- Since the time to complete graduate program degrees continues to increase, an MS degree program should not take more than two years of full-time study, including completion of any research or internship requirements. If the degree is pursued on a part time basis, faculty need to set a time of completion for planned part-time courses of study and also vigorously monitor student progress.

INTERDISCIPLINARY RESEARCH AND GRADUATE PROGRAMS IN THE PHARMACEUTICAL SCIENCES

Background

Interdisciplinary research has been called the wave of the future, because it is essential to the survival of the research universities, and for the majority of PhD graduates who will find employment outside of academia in an industry where collaboration is required(12). It is becoming more difficult to distinguish faculty by the type of research they perform with the proliferation of molecular techniques across all the traditional scientific discipline. To solve complex problems, crossing disciplines and collaborating with other researchers is essential, and some programs have merged to take advantage of this common language of research. Despite the potential advantages of interdisciplinary or collaborative research, many graduate students are still enrolled in department/discipline specific programs with minimal interdisciplinary interaction. There are “reasonable” explanations for not encouraging collaboration during a graduate program, such as the importance of working on one’s own research project, and developing a focused area of research expertise and set of skills. For graduate faculty, tenure and promotion decisions and peer recognition are still based on “individual” achievement, not contribution to a collaborative effort. Also, extramural funding of research is still based on the concept of the principal investigator. Despite these academic barriers, more recognition is going to those who successfully cross disciplinary lines in their research(13).

Universities are also recognizing that future funding, from government and industry will depend on their ability to address societal problems across disciplinary barriers. This often takes the form of research centers and institutes which offer alternative mechanisms to attract significant funding from industry and government agencies such as the NIH. More recently, the National Institute of General Medical Sciences proposed that it will accept training grant applications that cover two or more of the Institute’s seven support areas. One reasons for this change is to improve access to multi-disciplinary research training(14).

Pharmaceutical sciences by their nature, have been defined as interdisciplinary. However, could schools with active graduate programs in more than one pharmaceutical science be doing more to increase the extent of interdisciplinary coursework and research? As the extramural funds for research become more scarce, can the inherent interdisciplinary nature of the pharmaceutical sciences provide a unique niche for its graduate programs in the larger institution? This may become increasingly important at schools located in academic health centers (AHC) with large basic medical science graduate programs, which in some cases overlap in function and name with small programs in schools and colleges of pharmacy. At some academic health centers, there has been some movement into merging the basic science faculty into one biomedical sciences school which would be responsible for didactic instruction in all the health professional degree programs, and presumably graduate education as well.

Will survival of research and graduate education in the pharmaceutical sciences in the AHC environment be enhanced by becoming more interdisciplinary and then differentiating itself from its biomedical science counterparts, by combining with other university departments/disciplines to form new interdisciplinary structures, or by maintaining a traditional pharmaceutical science (Medicinal Chemistry, Pharmaceutics, etc.) department/discipline structure? Presently, over 25 out of 55 schools and colleges of pharmacy offering the PhD degree, offer a PhD in Pharmaceutical Sciences, sometimes as the only PhD degree program, and sometimes along with one or more PhD programs in traditional pharmaceutical science disciplines.

INTERDISCIPLINARY PROGRAMS IN SCHOOLS AND COLLEGES OF PHARMACY

The University of Florida College of Pharmacy home page describes “The Center for Drug Discovery” as a multidisciplinary group of faculty from several college departments, as well as faculty from the health science center and the department of chemistry. The Center faculty teach several graduate level courses focused on its primary research area, the targeting of drugs to specific organ systems utilizing retrometabolic drug design. The college home page also describes the “Center for the Neurobiology of Aging” which stimulates and supports interdisciplinary research and education on the neurobiology of aging. The Neurobiology of Aging Center faculty, postdoctoral, and graduate students come from 20 different departments at the University of Florida.

The University of Maryland merged its Pharmacology and Toxicology, Biomedical Chemistry, and Pharmaceutics programs into a Department of Pharmaceutical Sciences and offers a PhD in the Pharmaceutical Sciences. The faculty and graduate students are arranged into Research Focus Groups (RFG). The RFGs are:

1The program descriptions found in this report were obtained using the AACP home page directory of U.S. Schools of Pharmacy home pages. Some school’s home pages led directly to graduate program descriptions, program admission requirements, program and financial assistance application procedures, and a faculty/administrator contact for more information. These home pages were the exception. In most instances, graduate program availability is not obvious, and considerable searching is required before information is found. A common problem is that graduate education can only be obtained after accessing departmental home pages from the school home page. For students outside of pharmacy not familiar with its departmental designations, obtaining information on graduate programs can be time-consuming and confusing. Schools with graduate programs should revise their Internet home pages so that persons not familiar with pharmacy and the various pharmaceutical sciences, can easily distinguish descriptions and admissions information between the schools professional (PharmD), and graduate (MS, PhD) degree programs.
Cellular and Molecular Biology, Drug Design, Industrial Pharmacy Research, Drug Delivery/Metabolism/Pharmacokinetics, Pharmacology & Toxicology, Neuroscience, Oncology, and Natural Products & Biotechnology. Faculty generally belong to two or more RFGs. The RFG structure is purported to increase the opportunity for interdisciplinary research and collaboration among faculty and students. The program has a core curriculum required of all graduate students consisting of a Principles in drug design and development course, two research techniques courses, an interdisciplinary seminar, and a research ethics course.

The University of Colorado School of Pharmacy offers only a PhD in the Pharmaceutical Sciences, with research areas in medicinal chemistry, pharmacology, pharmaceutics, and toxicology. All students are required to take course in statistics, biochemistry, mechanisms of drug action, medicinal chemistry, pharmaceutics, and pharmacokinetics. Students have a temporary advisory committee during the first two years of the program, after which a permanent advisory committee is established to guide the student. Research rotations are arranged in at least two laboratories, and all students participate in a research seminar program. In addition, the University of Colorado has a Cooperative Program in Pharmaceutical Biotechnology (CPPB) which is staffed by faculty from the school of pharmacy and the department of chemical engineering. The CPPB research focus is in the development of biotechnology products for use as pharmaceuticals. Course work includes bioprocessing, polymer science, separation science, business planning and regulatory affairs, in addition to the traditional pharmaceutical sciences. Students from pharmacy and engineering conduct research in a collaborative atmosphere and much of the research is funded from industry grants.

Schools that maintain several traditional disciplinary PhD programs, but also offer the possibility of an interdisciplinary degree program, include the University of Georgia which offers both an MS and PhD in a “Toxicology Interdisciplinary Program.” A coordinating committee of faculty from Ecology, Agricultural and Environmental Sciences, Pharmacy, and Veterinary Medicine directs the program. Students can choose one of two focus areas: (i) human and animal toxicology; or (ii) environmental toxicology. The stated goal of the program is to provide strong interdisciplinary graduate training, research, and service programs in toxicology.

The examples cited above are not inclusive of all the inter- and multidisciplinary graduate programs available in schools and colleges of pharmacy, but they do illustrate differences in approach to interdisciplinary graduate education. However, it was impossible to determine if the program descriptions are accurate in their depiction of what actually occurs during an individual graduate student’s program. Combining separate department PhD programs under the rubric of a PhD in pharmaceutical sciences, while maintaining discipline specific research areas, may or may not accomplish the stated objective of the programs, learning and performing research in an interdisciplinary environment.

RECOMMENDATION 1: AACP should develop programming to address the issue of an optimal approach to interdisciplinary PhD degree programs in the pharmaceutical sciences.

INCORPORATING PRINCIPLES OF SCIENTIFIC INVESTIGATION INTO GRADUATE EDUCATION

In his inaugural address, “Paying Attention to the Wonder and Skepticism of Science,” AACP President Dr. Charles O. Rutledge asked the RGAC to examine the extent to which principles of scientific investigation are incorporated into graduate programs in the pharmaceutical sciences(15). Dr. Rutledge listed the following principles which are well developed in the classic treatise The Art of Scientific Investigation by, Beveridge(16). These are:
- the use of the hypothesis to devise new experiments;
- the importance of imagination and curiosity in productive thinking;
- the use of intuition - it is helpful in bringing fresh ideas, but they may be incorrect;
- the use of reasoning - it is helpful in bringing fresh ideas, but they may be incorrect;
- the difficulty but necessity of accurate observation of complex phenomena;
- expectation of extreme resistance to new ideas that displace established scientific paradigms.

Dr. Rutledge acknowledged that while some of these concepts are encountered when conducting a thesis project, an enhanced learning experience could not be experienced unless specific attention were paid to these concepts. Learning these scientific principles identified by Beveridge are consistent with the recommendations of the AACP Commission to Implement Change in Pharmaceutical Education (the Commission) which stated, “Graduate programs should focus on teaching students how to do research and how to use research tools in their disciplines to address important problems” and the National Academy of Science Committee on Science, Engineering, and Public Policy (COSEPUP) which stated, “Acquisition of research skills is central to the doctoral experience”(3, 17).

As does this program to ensure that all graduate students are exposed to the research concepts listed above? The COSEPUP report raised the concern that in some programs, PhD candidates can become so focused on a particular technique that there might be little opportunity for independent exploration of related fields or career options. COSEPUP identified the increased reliance of graduate student support on individual faculty research projects as contributing to this narrow focus by the PhD candidate. The Commission suggested that researcher success was very dependent on the guidance of an experienced mentor. However, over reliance on the availability and capability of faculty mentors may not ensure acquisition of the necessary skills and socialization into the research enterprise which is necessary for future success.

While mentor-mentee relationship has been widely recognized as important to the future success of a mentee, there is little evidence to support the view that PhD student advisors serve as a traditional mentor or “someone who serves as a career role model and who actively advises, guides, and promotes another’s career and training.” Although an advisor can function as a mentor, their functions are often more technical, including periodic monitoring of an advisee’s research, instruction in technical aspects of research, such as design, methodology, and use of instrumentation. In fact, most graduate students and their advisors found mentoring relationships “the exception rather than the rule”(18). Comments made by speakers at a National Academy of Science Convocation on Doctoral Science and Engineering Education supported the view that faculty PhD candidate advisors most often do not serve as mentors(19).

Assuming that graduate education in the pharmaceutical sciences is not significantly different than the physical and life sciences, what can be done to ensure that graduate students have an appropriate breadth of experience, are inculcated with the principles of scientific investigation, and have the appropriate socialization for future success as researchers or in alternative research-related careers. The RGAC suggests the following several approaches:
- didactic courses and seminars dealing with the topics of communication skills, technical writing, research ethics, literature searching, philosophy of science, and critical thinking;
- give students more responsibility in choosing their thesis research topic;
- before beginning thesis research, have student defend proposal in front of a faculty committee;
- have periodic evaluations of a student’s research project by a faculty committee.
The RGAC also discussed the potential role that AACP as an organization can play in assisting schools to provide the optimal programs for their graduate students. This issue is raised with the realization that at many institutions, a university administrative structure such as The Graduate School is the primary determinant of graduate degree program quality. While a previous AACP Commission on Graduate Education, the Lemberger Commission, strongly recommended voluntary external peer review of pharmaceutical sciences graduate programs, there is no evidence as to whether this recommendation has been implemented(20). Recently, the Social and Administrative Sciences Section of AACP has proposed guidelines for self-evaluation of its members' graduate programs. Should the other pharmaceutical sciences sections coordinate a similar effort to produce program self-study guidelines and case studies for use by member institutions?

RECOMMENDATION 2: The RGAC recommends that all pharmaceutical science sections consider drafting guidelines for the self-evaluation of its related graduate programs.

RECOMMENDATION 3: The RGAC recommends that AACP consider scheduling a graduate education focus group or forum that meets on a regular basis before or during the Interim or Annual meeting to address issues raised in the current RGAC report and other issues such as graduate program evaluation, graduate program management, and strategies for developing a program of research.

Am. J. Pharm. Educ., 61, 21S-25S(1997); received 10/1/97.

References
(2) Borchardt, R.T., “Chair report for the Research and Graduate Affairs Committee,” ibid., 60, 185-22S(1996).