Competency, Programming, and Emerging Innovation in Graduate Education within Schools of Pharmacy: The Report of the 2016-2017 Research and Graduate Affairs Committee.

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EXECUTIVE SUMMARY

Graduate education in the pharmaceutical sciences is a cornerstone of research within pharmacy schools. Pharmaceutical scientists are critical contributors to addressing the challenges of new drug discovery, delivery, and optimal care in order to ensure improved therapeutic outcomes in populations of patients. The American Association of Colleges of Pharmacy (AACP) charged the 2016-2017 Research and Graduate Affairs Committee (RGAC) to define the competencies necessary for graduate education in the pharmaceutical sciences (Charge 1), recommend collaborative curricular development across schools of pharmacy (Charge 2), recommend AACP programing for graduate education (Charge 3), and provide guidance on emerging areas for innovation in graduate education (Charge 4). With respect to Charges 1 and 2, the RGAC committee developed six domains of core competencies for graduate education in the pharmaceutical sciences as well as recommendations for shared

programming. For Charge 3, the committee made 3 specific programming recommendations that include AACP sponsored regional research symposia, a professional development forum at the AACP INterim Meeting, and the addition of a graduate research and education poster session at the AACP Annual Meeting. For Charge 4, the committee recommended that AACP develop a standing committee of graduate program deans and directors to provide guidance to member schools in support of graduate program representation at AACP meetings, develop skills for interprofessional teamwork and augment research through integration of Pharm.D., Ph.D., postdoctoral associates, resident, and fellow experiences. Two proposed policy statements by the committee are that AACP believes core competencies are essential components of graduate education and AACP supports the inclusion of research and graduate education focuses in its portfolio of meetings and programs.

KEY TERMS

Pharmacy, Pharmaceutical Sciences, Graduate Education, Research, Master's Degree, Doctor of Philosophy, Research and Graduate Affairs Committee

INTRODUCTION AND COMMITTEE CHARGES

The American Association of Colleges of Pharmacy (AACP) Bylaws charge the development of AACP's research, graduate education, and scholarship agenda to the Research and Graduate Affairs Committee (RGAC).[1] In accordance with this charge, the RGAC held frequent conference calls and asynchronous electronic communications prior to and after a meeting held in Alexandria, VA on October 18 and 19, 2016 to advance the charges for the 2016-2017 committee. The results of the committee's work are greatly appreciated by the team and are detailed in this report.

President Joseph T. DiPiro provided the following charges to the 2016-2017 RGAC:

1. Prepare a competency document for graduate students in the pharmaceutical sciences.

2. Recommend curricular development in collaborative research methodologies that pharmacy schools could implement.

3. Recommend programming for AACP meetings for the next 2 years that will be attractive to graduate students and advisors.

4. Recommend how the RGAC or a sub-committee (or associated committee) could improve graduate education by providing support, guidance, and insight into emerging areas for innovation in graduate education.

The RGAC worked as subgroups on specific charges with regular meetings of the entire group for full input and recommendations by all members. The charges were divided into Charges 1 and 2; Charge 3; and Charge 4 to be worked on by groups of 2 to 3 committee members for feedback to the entire RGAC at both the in-person and teleconference meetings. The first two charges were combined based on the agreement that collaborative research content across pharmacy schools (Charge 2) would require identified core competencies for graduate education in the pharmaceutical sciences (Charge 1). Charges 3 and 4 were led by separate subgroups. The full RGAC met by teleconference on a monthly basis with more frequent subgroup meetings in between full group sessions.

The committee reviewed all important documents relevant to each charge, including prior RGAC reports[2–5], Center for Advancement of Pharmacy Education (CAPE) competencies,[6,7] and other articles relevant to the above charges.[8,9] These documents were shared on the original conference call and subgroups were determined. Each subgroup met via teleconference separately with the planned initial report at the October 18 and 19 in person meeting at Alexandria, VA. Upon completion of the in-person meeting, thorough discussion led to group consensus concerning the overall thoughts/direction for each charge. Subgroup and full RGAC teleconferences were then used to advance each charge and an online file sharing system was used for both review of external documents and group report writing.

BACKGROUND

Defining Pharmaceutical Sciences as it Relates to the RGAC Charges

Both Master of Science (M.S.) and Ph.D. degrees are frequently awarded in the pharmaceutical sciences at many institutions. The M.S. and Ph.D. in pharmaceutical sciences includes training in a wide array of research areas including areas of focus from medicinal chemistry to health policy and outcomes. Due to this broad scope of training in our respective programs, we have used a broad definition of pharmaceutical sciences for the purpose of the aforementioned charges. The committee defined pharmaceutical sciences to encompass all research in graduate training in schools of pharmacy related to drug discovery, optimization, delivery, optimal dosing, as well as health outcomes and policy. Specifically, we defined pharmaceutical sciences to include, but are not limited to, medicinal chemistry, pharmaceutics, pharmacogenetics, pharmacology, biotechnology, pharmacoeconomics, pharmacoepidemiology, pharmacokinetics/clinical pharmacokinetics, clinical pharmacy/ pharmacotherapy, patient safety, regulatory science, health informatics, outcomes, and public health aspects of drug discovery and optimization. This broad definition is in contrast to the definition of the science areas by the Accreditation Council for Pharmacy Education (ACPE) standards,[10] which delineate separate definitions for pharmaceutical sciences, biomedical sciences, social and behavioral sciences, and clinical sciences in the didactic Doctor of Pharmacy curriculum. Ideally, the ACPE definition of the sciences and the definition of research in the pharmaceutical sciences would be uniform; therefore, it may be necessary to explore further the impact of this definition on academic pharmacy and more broadly on the graduate education community.

RECOMMENDATION 1

AACP should examine current and emerging research areas within pharmacy schools to clearly define graduate education in pharmaceutical sciences.

Core Competencies and Collaborative Curricular Development

Core competencies within pharmacy graduate education remain an important priority to advance both the mission of research and the promotion of our programs to students and professionals outside of the pharmacy discipline. A clear definition of the specific skills obtained during M.S. and Ph.D. education in the pharmaceutical sciences will allow schools of pharmacy to better recruit prospective students nationally and also clearly define

our programs' collective purpose. There is a clear need for individuals trained in the pharmaceutical sciences to advance drug discovery, development, and optimization of therapy within academia, industry, and governmental agencies. However, the specific core competencies that one acquires during such training remain to be clearly defined, thereby hindering cross institutional collaboration, impacting programmatic promotion to prospective students, and providing an inconsistent message to future employers regarding students emerging from our graduate programs.

Common Educational Outcomes for Pharmacy Curricula

By the early 1990's academic pharmacy had realized that collaborative development of core educational outcomes for pharmacy education could help guide curricular discussions among pharmacy schools and preceptors within the academy as well as guide curricular planning, delivery and assessment within pharmacy schools[6]. In 1992, the Center for the Advancement of Pharmacy Education (CAPE) Panel was initially formed by AACP and the Joint Commission of Pharmacy Practitioners. The Panel's work culminated in the first common set of educational outcomes focused upon the general idea of the knowledge, skills, and attitudes learners should possess in order to graduate from a doctor of pharmacy program and enter the profession. In addition, publication of the core curricular priorities of pharmacy programs was thought to help inform other health care practitioners regarding the breadth and depth of education that a newly minted Pharm.D. could be expected to have.

Since the initial version in 1992, three additional versions have been published (1998, 2004, and 2013).[6] The CAPE 2004 Outcomes were further assisted by supplemental outcomes written for each of the major disciplines comprising common pharmacy curricula including: anatomy, physiology, pathophysiology, biochemistry and molecular/cellular biology, libraries and educational resources, medicinal chemistry, pharmaceutics, pharmacokinetics, pharmacology, pharmacy practice, and social and administrative pharmacy. In CAPE 2013, the Panel sought to develop a living document that would be assisted by an active website whereby AACP Special Interest Groups (SIGs) and others could publish information and best practices in implementing and assessing the CAPE 2013 Educational Outcomes. The Panel developed the Educational Outcomes over a nearly two-year process that included vetting and input at nearly all national pharmacy organization meetings, and

many regional meetings as well. Those individuals with interest in pharmacy education had many opportunities to provide input for the Panel's consideration and the result was a well-received and widely acclaimed set of Educational Outcomes that have proven invaluable to the academy. As such, ACPE incorporated the CAPE 2013 Education Outcomes verbatim in Standards 2016.[10]

The CAPE 2013 Educational Outcomes include four core domains: foundational knowledge, essentials for practice and care, approach to practice and care, and personal and professional development. Each core domain is further defined by subdomains, and under each subdomain are examples of possible learning objectives that pharmacy programs could incorporate in their curricular outcomes. Recognizing that pharmacy programs may want to further advance a subdomain and/or utilize slightly different learning objectives to achieve the desired outcomes, the CAPE 2013 Panel simply recommended example learning objectives and encouraged creativity and innovation among programs to enhance the learning objectives and share those with the academy through publishing in the *American Journal of Pharmaceutical Education* or the CAPE 2013 website.

Overall, the CAPE Educational Outcomes have achieved the goals of guiding curricular discussions among pharmacy programs and preceptors, as well as in guiding curricular planning, delivery, and assessment within pharmacy schools. The proven utility of the CAPE 2013 Educational Outcomes led the AACP Leadership to charge the RGAC with developing an analogous set of Educational Outcomes for graduate programs in pharmacy schools. Like CAPE, the general idea is that development of a recommended set of educational outcomes for graduate curricula in pharmaceutical sciences should help guide curricular discussion among graduate programs and help guide curricular planning, delivery, and assessment within the graduate programs housed in pharmacy schools. Further, development of these educational outcomes may facilitate collaboration among pharmacy schools with significant emphasis on graduate education and research.

Core competencies for graduate education within individual tracks at a given institution have been reported as early as 2011.[9] Individual programs also have developed such core competencies for training within their institutions including the University of Minnesota, University of North Carolina, University at Buffalo, and others (personal communications). Furthermore, the report of the 2012-2013 RGAC included a possible action

plan to "Define and develop a set of required competency-based skills for all graduates to acquire, … we should perhaps look into a CAPE-like taskforce for graduate education."[3]

Consistent with these goals, the 2016-2017 RGAC sought to develop a competency document for graduate education in the pharmaceutical sciences. Successful development and agreement upon competencies will allow for better definition of the skills obtained by students emerging from our programs and will allow for shared content across institutions to meet shared competencies in education (Charge 2).

During the initial committee meeting in Alexandria, VA, it quickly became apparent to the committee that preparing a set of competencies that covered all graduate programs in the pharmaceutical sciences could be particularly difficult for a variety of reasons. The range of training programs, independent nature of the programs, and, in many Universities, local oversight of these programs by a multidisciplinary graduate college appeared to create discipline specific goals that might not be easily categorized. However, there are key competencies that could be agreed upon by our interdisciplinary panel that were required of successful graduates and sought after by their future employers. Essentially, regardless of discipline and in addition to the discipline-specific foundational knowledge required of graduate students, all graduate programs should encourage the development of those traits required of scientists: conduct and present ethical, high quality research; grow and adapt throughout one's career; and display strong interpersonal skills, be professional, and develop as a leader.

PROPOSED POLICY STATEMENT 1:

AACP believes that core competencies are essential components of graduate education.

Development of a Set of Core Competencies for Graduate Education in Pharmaceutical Sciences

The committee developed six domains of core competencies for graduate training in the pharmaceutical sciences (Table 1). These domains consist of foundational knowledge, research, scientific communication, education, leadership and management, and personal and professional development. Domain 1 is foundational knowledge, which is to be defined by an individual track within a specific graduate program. The foundational knowledge domain will contain areas of expertise that are unique to that specific educational track within the

pharmaceutical sciences. For example, the specific foundational knowledge for a student trained in the clinical pharmaceutical sciences was previously developed and reported for the University of Pittsburgh and can be delineated for domain 1.[9] In addition, domain 1 can be personalized based on the enrolled students' prior research and/or clinical experience from their undergraduate or professional degrees through the assessment of attained versus needed individual competencies. Importantly, it is the intent that the specific foundational knowledge will be applied to the educational experiences gained in domains 2 through 6.

Domain 2 (Research) encompasses skills required for the systematic conduct of generating or synthesizing new knowledge using best research practices. These competencies include skills for identifying and evaluating what is already known, identifying where gaps exist in that knowledge, and generating appropriate and specific research questions. Once research questions have been developed, further competencies in this domain include identifying and/or developing and using the most appropriate and ethically sound techniques for investigating these questions and interpreting and analyzing the results. Development of conclusions and considerations of limitations and alternative conclusions are also consider essential to this domain. Finally, identification of future areas of research exploration based on the findings are important skills for development.

Domain 3 (Scientific Communication) focuses on those skills required for disseminating research findings within the scientific community and obtaining research funding. These skills would include, but not be limited to, written and oral presentation skills to communicate ideas to a variety of scientific audiences, the ability to identify potential funding sources, and preparation of proposals. This domain also includes competencies related to the review processes involved in grant and manuscript writing, including both providing and responding to critiques. Adaptability in responding to critiques and critically assessing the literature are considered essential skills needed for success as a researcher in the pharmaceutical sciences.

Domain 4 (Education) establishes the skills required of graduates for becoming great teachers and mentors. Opportunities exist throughout one's career for educating students, colleagues, funders, policymakers, and the general public. Skills required to communicate with and educate these stakeholders are often different from those required for presentation of research findings to others within the scientific community, which led to the committee's decision to separate these skills into their own domain. Importantly, it is not the intent of this

domain to suggest that all graduate students pursue academic careers after completing their graduate training; rather, the skills in this domain are similarly necessary whether engaging students in a classroom setting or advocating for research when communicating with policymakers and the general public. Indeed, the competencies highlighted in the education domain are essential for creating enthusiasm, improving communication with the public, and sustaining support for research in the many research communities to which graduate students will become members.

Domain 5 (Leadership and Management) focuses on the competencies required to work as both an independent researcher and in a team environment. These skills also translate to becoming effective leaders in the community and workplace. Importantly, these skills include both personnel and project management and the ability to develop a team. Ensuring that graduates are equipped with the skills to mentor students, hire individuals in their labs, and develop effective teams is an essential skill set that is frequently learned only after attaining one's first full-time position. By establishing this domain, it is the intent of the committee to ensure that students develop these critical skills prior to completion of their degree to catalyze their success in a research career. Providing graduate students with training in these essential skills will result in students who are more employable and advance their development as leaders in their fields of study.

Domain 6 (Personal and Professional Development) incorporates skills needed to support lifelong development across one's career. This domain seeks to address the interplay between a student's personal and professional life and provide a framework for approaching the challenges and opportunities in their personal environment that may influence their professional lives. One of the most essential skills for long-term success is adaptability when facing challenges, and the additional skills of self-awareness and self-direction will enable students to embrace challenges, more easily identify opportunities and demonstrate career agility when necessary. Finally, the skill of self-promotion is balanced by professionalism and cultural awareness to cultivate students who are advocates for both themselves and their colleagues.

Curricular Development

Charge 2 is to recommend curricular development in collaborative research methodologies that pharmacy schools could implement. The committee consensus was that general agreement on the core competencies (Charge 1) is necessary prior to full recommendations for shared content. It was determined that several areas are clearly common across institutions/tracks, which include but are not limited to grant/proposal writing, biostatistics, and critical thinking, thereby, representing a starting point for shared content consideration. Based on the need for agreement on the core competencies, it is suggested that pharmacy schools identify both the areas of need within the competencies. It is also recommended that the shared content Charge 2 should be more thoroughly explored by the 2017-2018 RGAC.

RECOMMENDATION AND SUGGESTION

Recommendation 2: The 2017-2018 Research and Graduate Affairs Committee or a related committee should utilize the competencies outlined above to identify and/or develop shared content for graduate programs to use to enhance training in common core competencies that meet the demands of training and equip students with the skills to succeed within their research careers.

Suggestion 1: Pharmacy schools should adopt a set of core competencies for graduate education that include discipline-specific knowledge in addition to essential skills for well-rounded and sought after graduates.

Development of Programming to Engage Graduate Students and Advisors in AACP

To assist in attracting Pharm.D., Ph.D., post-doctoral associates, graduate advisors, and basic sciences faculty to AACP, the following recommendations are proposed: 1) AACP sponsored regional research symposia; 2) professional development forum at AACP INterim Meeting; and 3) the addition of a graduate research and education poster session at the AACP Annual Meeting. This list is placed in priority which the committee felt will allow for an expansion of AACP membership as well as an increase interest by graduate program educators in both the AACP INterim and Annual Meetings. Collectively, the programming recommendations send a strong

message to membership that AACP supports the inclusion of research and graduate education as critical components of its portfolio of products, programs, services, and tools to carry out its mission.

AACP Sponsored Regional Research Symposia

An area of growth in faculty interest in AACP is through expansion of research emphasis and graduate education. There is a recognized need to increase science programming at AACP meetings in alignment with AACP's mission to "advance pharmacy education, research, scholarship, practice and service, in partnership with members and stakeholders, to improve health for all," and as such, AACP has planned to establish a portfolio of research and graduate education programming as part of the 2016 Strategic Plan. This committee believes an effective approach would be to host regional meetings, which would allow students and faculty to attend a meeting in their local vicinity while reinforcing AACP's commitment to research and graduate education.

Using the regional meeting model, there are also opportunities for AACP to partner with other organizations that already have regional research meetings that are well attended by the AACP target audience. For example, in certain regions the American Association of Pharmaceutical Scientists (AAPS) have very strong student chapters that already host one-day annual regional meetings. If AACP were to co-sponsor these events, there would exist opportunities to award prizes to support student attendance to a future AACP INterim or Annual Meeting. Such co-sponsorship would demonstrate AACP's commitment to research and graduate education while also encouraging future long-term AACP membership.

With the broad nature of disciplines represented in pharmacy graduate education, AAPS need not be the only partner organization in establishing regional research symposia. Therefore, in regions where there is not already an existing AAPS-hosted regional meeting, AACP should consider exploring additional partner organizations with overlapping membership and strong student representation. Alternatively, AACP could partner directly with member schools to host regional meetings. In these cases, AACP could provide support and promotion of such events, but the host institutions would accept responsibility for the organization of the conference.

The benefits of the above proposed models are that where a strong infrastructure already exists, co-sponsorship by AACP would show the commitment of the Association to research, but also plant seeds for future membership. Where the infrastructure does not already exist, AACP can showcase its passion for research by taking the lead, empowering faculty, provide students and faculty the opportunity to network and build potential regional collaborations, and also be a feeder to the INterim and Annual Meeting through awards. However, to entice those to attend the INterim and/or the Annual Meetings, additional recommendations are presented below.

Professional Development Forum at AACP INterim Meeting

Given the graduate competencies discussed above, there are additional opportunities for AACP to engage graduate faculty and students by establishing programming that will support skill development. Moreover, it is not uncommon for organizations to include such professional development programming that is geared toward graduate students in in their association-wide meetings. Creating a professional development forum in conjunction with the AACP INterim Meeting would serve not only to meet the needs of the graduate education community but also would expand membership and encourage attendance of graduate students and faculty from pharmacy schools at AACP meetings.

Suggested topics to be covered during such a workshop would include precisely those types of skills described in several of the domains outlined above, including but not limited to, scientific proposal writing (domain 3), presentation skills (domain 3) and team building (domain 5), as well as those skills needed for taking the next steps in one's career path, such as CV writing and interview skills. These topics are suggested as they are universally relevant across all scientific disciplines at pharmacy schools. Furthermore, these are skills that graduate students and faculty must hone throughout their careers and require practice and repetition to be effective.

Addition of a graduate education poster session that focuses on teaching strategies within the Ph.D./M.S. educational framework at AACP Annual Meeting

The AACP Annual Meeting offers another opportunity to showcase a commitment by AACP to support and enhance research and graduate education. While focusing primarily on education, this meeting is an ideal target for attracting graduate advisors and particularly those students who may be exploring academic careers. The two key hurdles in building this audience at the AACP Annual Meeting are increasing graduate education focused content and reducing barriers to access.

One program recommended by the RGAC is a poster session at the AACP Annual Meeting focused on graduate education and research. Graduate programs often develop innovative graduate courses, and many of these innovations would be broadly appealing to educators who also work with Pharm.D. students. Including this session at the AACP Annual Meeting would thus promote a dialogue between faculty in the graduate and professional programs and would bring synergy to research training to the benefit of all. Graduate advisors would have opportunities to present at this poster session or learn more about the innovations taking place in other graduate programs. Meanwhile, graduate students would also be encouraged to practice their oral presentation skills by presenting their research at this poster session, further supporting the competencies outlined above. These students' attendance at the AACP Annual Meeting would be extremely valuable as a networking opportunity if they are interested in an academic career. Collectively, the enhanced visibility of the graduate programs and communication between the various graduate students and faculty could result in the AACP Annual Meeting becoming an ideal location to discuss and promote best practices and innovations in graduate education and research (Charge 4; see below for more discussion).

Another hurdle in attracting the graduate education community is the cost associated with attending the AACP Annual Meeting. In some cases, to offset the cost of attending this meeting, awards given to graduate students at the regional meetings proposed above can be used to cover registration and travel. The graduate education community should also consider promoting award mechanisms already in place, such as the AACP Walmart Scholars Program, to enhance graduate student attendance at the Annual Meeting. While the total number of awards given between these two mechanisms would reduce out-of-pocket costs for only a subset of student attendees, the committee believes that even small reductions in the financial barrier will work in concert

with increases in attractive programming to improve graduate student and advisor attendance at the AACP Annual Meeting.

PROPOSED POLICY STATEMENT AND RECOMMENDATIONS

Policy Statement 2: AACP supports the inclusion of research and graduate education focuses in its portfolio of meetings and programs as integral facets of pharmacy education.

Recommendation 3: AACP should establish a series of regional research meetings in partnership with complimentary organizations (e.g., AAPS) and member schools.

Recommendation 4: AACP should create a professional development forum for graduate students and program directors in conjunction with the INterim Meeting.

Recommendation 5: AACP should establish a poster session at the Annual Meeting for graduate education and research.

Emerging Areas for Innovation in Graduate Education

A survey of graduate education and postdoctoral training across all pharmacy schools was conducted in March 2016 by the 2014-2016 AACP RGAC.[5] The survey data estimate that over 50% of schools of pharmacy currently have strong, comprehensive graduate and postdoctoral training environments. Through productive interactions among schools, there is an opportunity for those with less-developed graduate and postdoctoral education and training environments to collaboratively increase the scope and level of their programs. Such interactions would also enhance the already strong training environments by extending expertise through between-college/school collaboration. Also, 65% of schools report that their faculty are mentors for graduate programs in other disciplines or for interdisciplinary graduate programs, creating opportunities to incorporate

novel aspects of training, even in traditional, school-based programs that are already in robust training environments.

The March 2016 survey summary also provided data on the career pathways of graduate students and postdoctoral trainees. For Ph.D. students, just over 40% of graduates enter careers in academia/research institutes, with approximately the same percentage heading to industry upon graduation. The remaining 20% balance of graduates are split between government and other careers. For M.S. students, 65% of graduates take positions in industry and 21% in academia/research institutes, with the balance entering government and other career areas. Post-Pharm.D. and post-Ph.D. fellows both take positions roughly equally in academia/research institutes and industry, with small percentages moving to government or other. Overall, these data suggest that any AACP-supported efforts to enhance graduate education cannot be "one-size-fits-all." Thus, it will be important to promote the development of knowledge and skills that support career development in academia/research institutes and industry.

Graduate programs in schools of pharmacy are somewhat unique in that there is a common appreciation for understanding drug discovery and development through health outcomes and policy, defined broadly. This overarching principle likely exists in nearly all pharmacy schools, regardless of whether they have a single focused graduate program or multiple programs that cross disciplines. As such, students are presented with opportunities for graduate training that result in uniquely qualified and specialized graduates who can address high impact problems and challenges to improve health. Graduates have drug discovery and development skills, which fill the gap in basic science research in academia and the pharmaceutical industry; rigorous training in pharmacokinetic/pharmacodynamic relationships, which is essential in the conduct of clinical trials and development of treatment protocols; and thorough training in the analysis of large datasets to understand drug action, which is important in pharmacoeconomics, pharmacogenetics, health outcomes, medication compliance, identifying novel uses for drugs, and personalized pharmacy care.

The breadth of research areas and training opportunities in schools of pharmacy represent a considerable strength, but also creates a challenge for AACP to develop programs to aid existing programs and identify areas of innovation. One area recommended for greater emphasis is using interprofessional working models,

communication, teamwork, and skill building for career agility. AACP could help graduate pharmacy programs to provide their students, who will ultimately specialize in a specific discipline of pharmaceutical science, to better understand and communicate more effectively with other specialists (professionals) in pharmaceutical science by providing a shared, strong background in the translational pathway from discovery to commercialization and outcomes. Emphasis on major concepts and the current state of knowledge (e.g., theory, methods, ethics, and review of classic and/or exemplary studies) in the translational process from drug discovery, development, regulatory, clinical pharmacology to commercialization of therapeutic agents and evaluation of outcomes would be beneficial.

It will be important to ascertain the degree to which participation of faculty, graduate students, and postdoctoral students in schools of pharmacy rely on discipline-based organizations to augment and improve their programs. While these could include, for example, AAPS or the American Society for Pharmacology and Experimental Therapeutics (ASPET), a high rate of interdisciplinary faculty participation would provide unique expertise from multiple groups to drive innovation, including diverse areas such as chemistry, molecular biology, engineering, and epidemiology.

AACP Standing Committee and School of Pharmacy Support

In order for AACP to have a sustained impact in promoting and improving graduate education and in identifying areas for innovation, it is recommended that a standing committee comprised of graduate program deans/directors be established within AACP, analogous to the Graduate Research, Education and Training (GREAT) group in the Association of American Medical Colleges (AAMC). The committee will be charged with sharing information, identifying best practices, developing long-term plans for improving graduate education in schools of pharmacy, and identifying and coordinating potential areas of innovation with AACP. While AACP does greatly benefit from the activities of the Graduate Education SIG, it is important to note that SIGs do not have dedicated staff support, which might prove critical in organizing efforts on a larger scale. Thus, a new committee, or a community of practice such as recently piloted by AACP,[11] is proposed to aid both the RGAC and the Graduate Education SIG in sustaining impact of our collective efforts.

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Initially, it is recommended that this group review data collected in the prior RGAC surveys of graduate programs. The graduate programs represented likely will include medicinal, bioorganic and computational chemistry, pharmacology and experimental therapeutics, pharmaceutical chemistry and engineering, clinical pharmacy, health outcomes, pharmaceutical policy and administration, and drug information. Again, understanding and increased communication between these disciplines within pharmacy graduate programs will augment the graduates' career agility.

It further is recommended that the graduate deans/directors group identify focus themes in NIH support (e.g., personalized medicine) for graduate training and early career training and evaluate whether current programs meet identified needs. Incorporation of ongoing efforts by NIGMS in this area – i.e., "the modern Ph.D." will be also be important.

Finally, to ensure success of the group and enhance collaboration across graduate programs, it is suggested that schools provide support, on an annual basis, for their representative on the committee to attend programs focused on graduate education at the AACP INterim Meeting as well as support for regional school efforts in graduate education. The long-term goal is to establish a strong, self-regulating group that can direct AACP's effort in supporting innovation in graduate education at schools of pharmacy.

Interprofessional Skill Development and Training Program Integration

Also, it will be important to identify areas/skills and methods for training that might be outside the expertise of scientific societies (e.g., AAPS, ASPET) or that are cross-disciplinary. This could include skills for beginning a career in academia/industry/biotech, building collaborations and networking, and the use of public resources such as genetic and drug databases and libraries. An example of an important area is development of collaborative training with engineering and other disciplines (computer engineering), which would enhance training in areas such as drug delivery, biologics, chemoinformatics and drug repurposing. A second example is the development of collaborative training with biomedical informatics and computer science to go beyond standard statistical approaches and apply machine learning and deep learning models to uncover patterns in big

data to better explore health outcomes. The graduate dean/directors, being engaged in other scientific and professional societies, should be well positioned to identify unique opportunities for AACP.

Graduate programs in schools of pharmacy should emphasize and build on their uniqueness described above. It is suggested that this should involve better collaboration and integration between the M.S., Ph.D. and Pharm.D. programs, as well as among postdoctoral fellows, clinical fellows and residents to build translational training and research and to conduct studies at the interface of basic and clinical research including preclinical experimentation necessary to initiate first-in-human studies. Emphasis should be placed on interprofessional working models, communication and teamwork, and building skills for career adaptability. As elaborated in previous AACP reports,[12,13] those undergoing clinical training benefit from the conduct of clinical/translational research by obtaining a greater perspective and understanding of basic research. It would also be beneficial for graduate students and postdoctoral fellows in the basic pharmaceutical sciences to obtain a stronger clinical understanding and perspective. Ideally, this could be accomplished through shared, integrated and combined laboratory-based bench and clinical experiences. Pharm.D. students represent a well-trained group for pursuing graduate training in the general area of the pharmaceutical sciences. This is suggested by the results of the AACP survey, which identify over approximately 340 Pharm.D. graduates in fellowship training in responding schools; additionally, 150 Pharm.D. graduates of reporting schools are indicated to be in academic postdoctoral positions. It is important to continue to devise programs by which Pharm.D. students pursue graduate training, either in joint degree programs or as a component of fellowship or residency training. Such training will position them well for positions in academia or industry, as well as for emerging areas in clinical/translational and regulatory practice.

RECOMMENDATIONS AND SUGGESTIONS

Recommendation 6: AACP should develop curricular content for graduate programs to use that includes interprofessional working models and builds on those skills needed for career agility.

Recommendation 7: AACP should establish a committee or community of practice composed of graduate program deans/directors tasked with identifying best practices and developing plans for long-term improvement of graduate programs across pharmacy schools.

Recommendation 8: The newly formed committee or community of practice (as outlined in recommendation 7) should utilize previously collected RGAC data to ascertain the current state of graduate education across schools of pharmacy.

Recommendation 9: The newly formed committee or community of practice (as outlined in recommendation 7) should identify NIH programs supporting graduate and early career training and evaluate if/how current graduate training in pharmacy schools aligns with those themes.

Suggestion 2: Pharmacy schools should provide support for graduate program directors to attend AACP programming focused on graduate education at the AACP INterim Meeting to encourage greater cross-talk and synergy between programs and schools.

Suggestion 3: Graduate programs in pharmacy schools should foster collaboration with Pharm.D. programs, as well as with postdoctoral and clinical fellows and residents, to emphasize their strength at the interface of basic and clinical research.

CONCLUSION AND CALL TO ACTION

The wide array and diversity of graduate training options offered at pharmacy schools present significant challenges with respect to addressing all of their needs through a single set of recommendations. However, this breadth of training also offers an opportunity for AACP to focus its efforts on skills that are universal to all disciplines, such as how to conduct a well-designed and ethically sound study and how to enhance a researcher's impact on science and society. The synergy between the different graduate program training options is mirrored

by the potential for cross-fertilization between graduate and Pharm.D. programs to advance research from discovery to clinical intervention. Such efforts in collaborative research are critical for the success of national research initiatives. The recommendations outlined above should thus be viewed as opportunities for AACP to support multiple facets of the development of the pharmacy research workforce, from ensuring that trainees receive an education that prepares them for the careers of tomorrow to providing a niche within AACP programming for members of the graduate education community to strengthen competencies, collaborate, and innovate for the future of research training in the pharmaceutical sciences.

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TABLES

Table 1. Six Domains of Graduate Education in the Pharmaceutical Sciences

Domain	Core Competencies
1. Foundational Knowledge	Foundational knowledge is defined in each track within the given pharmaceutical science graduate education program. Each of the following domains 2 through 6 are to be applied to the specific area of foundational knowledge.
2. Research	Literature Review and Critical Evaluation Hypothesis Generation Research and Study Design Good Research Practices Interpretation and Analysis Research Ethics (Human, Animal, Other)
3. Scientific Communication	Scientific Proposal Writing (Grant/Contract, Proposal/Executive Summary, Report, and Intellectual Property Disclosures) Research Dissemination Scientific Review and Response to Critiques Oral Communication
4. Education	Teaching and Learning Mentorship (Peer, Employee, Trainee) Advocacy (Policymakers, Public, Private)
5. Leadership and Management	Effective Leadership and Teamwork Innovation and Entrepreneurship Project Management Personnel Management
6. Personal and Professional Development	Self-Awareness and Self-Direction Adaptability Self-Promotion Professionalism Cultural Awareness and Sensitivity