
The Integrated Biomedical Science Graduate Program at the University of South Carolina

Richard Hunt

University of South Carolina, Columbia, South Carolina 29208

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Until recently, graduate programs in the biomedical sciences were usually based in the traditional medical school departments (microbiology, biochemistry, pharmacology, anatomy, pathology, and physiology) and in biology departments. However, these departments have become increasingly irrelevant as far as the training of PhD students is concerned since biomedical research is now carried out in many parts of a university. Moreover, faculty members from disparate parts of a university are often housed in dedicated biomedical research buildings. At the University of South Carolina, the Medical School departments have combined their doctoral training programs with those of sections of the biology, chemistry and psychology departments, the College of Pharmacy and the School of Public Health to form the Integrated Biomedical Science Graduate program.

15 Graduate students participating in doctoral (PhD) education programs constitute the principal workforce in the biomedical research activities conducted in most research universities and medical schools in the United States. As faculty take on
20 more academic responsibilities, they rely on graduate students to carry out much of the hands-on laboratory work that leads to the generation of knowledge in the form of published papers. The work of graduate students also leads to the
25 generation of further federal, industrial and foundation grants to support research. These grants, through the provision of overhead funds, are nowadays supporting more and more of the mission of medical schools and universities. A strong
30 graduate program attracts the best students who do the best research and, as a result, generate more research papers and grants. The whole university benefits from strong graduate programs in the biomedical sciences because, currently, the
35 National Institutes of Health (NIH) are the leading federal source of research funding.

As the number of grants and students in a university program increase, it becomes possible for the university to obtain separate funding to support
40 graduate students in the form of stipends from training grants from the NIH and also from private organizations such as the Howard Hughes Foundation. In many major universities, such training grants support the majority of graduate
45 students in the biomedical sciences. They also provide support for post-doctoral fellows. The University of South Carolina (USC), unfortunately, has had little success in obtaining training grants from the NIH because of a lack of a critical mass of
50 faculty and existing graduate students in many of its colleges. There has also been a lack of well qualified applicants to many biomedical research

graduate programs at USC. It is a fact of academic life that a strong graduate program generates money
55 that often leads to an even stronger program. It has been evident for many years that a stronger biomedical sciences graduate program is needed so that the university may compete nationally, not only for funds to support its biomedical graduate
60 programs but also for research grants and contracts.

HISTORY

Basic Science departments in American Medical Schools are traditionally organized around the core courses taught in the first two years of medical
65 education: These disciplines are Anatomy (now often contained within Cell Biology and Developmental Biology departments), Pharmacology, Pathology, Biochemistry, Microbiology and Immunology and Physiology. In
70 addition to training medical students in the basic medical sciences, these six departments also frequently offered Doctor of Philosophy (PhD) and Master of Science (MS) degrees.

The University of South Carolina School of
75 Medicine (USCSOM) is one of the younger and smaller medical schools in the United States. It was authorized by the South Carolina legislature and the South Carolina Commission of Higher Education in 1973 and accredited in 1975. It admitted its first
80 class of medical students in 1977 and now has a total of approximately 300 medical students in the four years of the medical curriculum. Unlike most medical schools, the USCSOM has no biochemistry department and teaching of this subject is carried
85 out by the faculty of the Department of Chemistry, a unit of the College of Arts and Sciences. By 1981, four of the five basic science departments at the USCSOM had their own small graduate program, often admitting only one or two students per year,
90 most of whom were recruited locally. These

students were offered few courses dedicated specifically to them and usually took basic science courses along with the medical students. To overcome the lack of resources for graduate students in the individual departments, the biomedical science graduate program at USCSOM was formed by amalgamating these programs under a single administration. Although administration was centralized, lack of funds did not allow optimal recruitment. Most students initially chose a mentor, entered the individual departments at the beginning of their graduate education and remained there.

The Biomedical Sciences Graduate program slowly accepted an increasing number of students as USCSOM grew in the number of faculty and faculty-initiated research projects. Subsequently, the five original basic science departments merged into three. A committee consisting of the overall program academic director and the Director of the Biomedical Program plus representatives of the three departments selected well-qualified candidates whose credentials suggested they would eventually disperse in roughly equal numbers to each of the departments to carry out their thesis research. Many students did not select a potential mentor until they arrived in Columbia and selection could be delayed until rotations had been carried out in a few laboratories.

By 2006, and after administrative reorganization, the USCSOM Biomedical Science Graduate program was admitting 8 to 10 new students per year with a steady state number of about 40 and a budget, exclusive of tuition, of about \$250,000. The entire budget was provided by the Dean. By now, a large proportion of the students admitted were from overseas, mainly from China and India, something that was (and still is) common to most medical graduate programs in the United States and Europe.

From time to time, faculty of the USCSOM who were interested in training graduate students got together to submit a training grant to the NIH but none was successful. A common criticism was that as that there was no critical mass of faculty to teach or mentor the students (only about two thirds of the approximately 35 faculty were well enough funded to pay for a graduate student's research expenses) and, as far as United States citizens were concerned, there was no critical mass of current students or future applicants. The number of American students is important because only these can be supported from NIH training grants. Nevertheless, the graduate program was graduating successful students who obtained post-doctoral positions in prestigious institutions in the US (Harvard University, University of California, MD Anderson Cancer Center, Baylor College of

Medicine, Johns Hopkins University National Institutes of Health and many more). Some students chose to pursue their post-doctoral years abroad in such organizations as the Karolinska Institute (Stockholm, Sweden) and the Imperial Cancer Research Laboratories (London, England).

In addition to the lack of a critical mass of American students in the USCSOM program and the lack of the possibility outside funding, the number and breadth of course offerings changed little. A similar situation pertained in some of the other biomedically-oriented departments at USC.

THE NEED FOR INTEGRATION

In addition to the need to attract a larger number of well-qualified American Graduate Students, a prerequisite for funding from the federal government, USC needed a stronger program to attract the very best new faculty when the university administration identified biomedical science research as one of its growth priorities. The existing small program at the medical school and similar small programs based on traditional teaching departments on the main campus, had become irrelevant, especially as research faculty consolidate into facilities that are based on research interest rather than teaching department.

A critical mass of students and faculty is required for a dynamic program

Clearly, a problem of critical mass existed in many biomedically-oriented departments at the university including the School of Medicine, the Arnold School of Public Health (Exercise Science), the South Carolina College of Pharmacy (Basic Pharmaceutical Sciences) and the College of Arts and Sciences (Departments of Biology, Chemistry (Biochemistry Section) and Psychology. None of the individual departments had sufficient faculty to offer a truly broad range of research opportunities and courses to potential students and none of the individual departmental programs had the sufficient students to offer the peer interactions that are necessary.

What was needed was quite clear:

- More faculty mentors
- More and better qualified students recruited from within the United States
- More choice of research options for the students
- More choice of elective courses
- More (and better attended) seminars
- Better funding for the program as a whole

The need for more faculty in the biomedical sciences was addressed at the beginning of this century by the Centennial Plan and the Faculty Excellence Initiative but major expansion to the size of many competitor universities is a long way off, even though a new biomedical research center, the Discovery Building on the Vista, is under construction which will bring together funded faculty from all parts of the university into a central location (making departmental distinctions even more irrelevant).

It was very clear that none of the obvious problems would ever be solved by remaining in isolation as small departments (or even schools). Moreover, the fragmentation of the graduate programs has become an anachronism as faculty come together in the new biomedical research center. In addition, the organization of university departments based on course offerings to undergraduates and medical students, hindered faculty interactions. What was required was to combine the biomedically-oriented graduate programs into the most flexible format possible. Not only would this offer a much larger and attractive program to potential students but it would also serve to bring faculty together under the aegis of the graduate program and foster more research interactions.

The Solution

The solution was quite clear. Combine the graduate programs of the various biomedically-oriented departments across the USC campus. Students would be recruited for the joint program, *The Integrated Biomedical Science Graduate Program* (IBMSGP), and would enter their first year without any commitment to a mentor or department. In this “umbrella” year, all students would take one of two lecture tracks: Molecular and Cellular Biology or Neuroscience, both of which would teach the fundamentals of the biology of cells and between which the student could easily switch. During the umbrella year, students would spend three rotation periods in laboratories of their choice selected from a menu of more than 90 potential mentors from all participating departments on the main campus located in the center of Columbia and at the Medical School located on the Veterans’ Administration Hospital campus. By the end of the first year, after successful completion of all core courses, the student would affiliate with the department of their chosen mentor and spend the remainder of their time pursuing a PhD degree in the department of their mentor. This period would be about five and a half years, a time that is usual for earning a PhD in the biomedical sciences in the United States.

The IBMSGP was proposed to Vice-President Harris Pastides, now the USC President. The formation of the IBMSGP was agreed and the program recruited its first students for the fall of 2008.

Funding

The various departments contributed monies to the pool of stipend support according to the number of faculty who might draw students from the program. However, there was a need for administrative support. In addition, a potential problem was that, in a single year, one department or school might get fewer students than justified by the stipend money contributed. This could lead to an early collapse of the program if departments felt that they were putting in more than they got out. To avoid this and to pay for administrative costs, the USC Office of Research and Economic Development, the Graduate School and the USC INBRE program contributed an additional \$120,000 per year for three years.

The First Year

With little advertising, other than a web site and word of mouth, the IBMSGP recruited students starting in late 2007 for admission in August 2008. A higher number of American and foreign applicants were received than in previous years. Twenty-six students were admitted. Twelve of these were from overseas (India, China and Nepal) and fourteen were from the United States. The American students included seven minority students (five African Americans and two Hispanic Americans). Five of these were graduates from the Post-baccalaureate Research Education Program (PREP) that is funded by the NIH and which is described by Dr Bert Ely in this issue of JSCAS. This large proportion of minority students means that in five years, the IBMSGP is expected to graduate a significant proportion of African American PhDs in the biomedical sciences in the United States.

The result of the integration of graduate programs in the biomedical sciences has clearly led to more applications, both from the United States and abroad. But has there been an improvement in their credentials? The GRE scores of American students in the medical school’s former biomedical science graduate program, verbal and quantitative, were 47th and 54th percentile respectively. This rose to 62nd and 70th percentile for the non-minority students admitted in 2008 and the numbers remain similar for those interviewed for fall 2009. The overseas students also showed better GRE scores.

The foreign students continuing from the former program had scores in the 60th and 78th percentiles which rose to 71st and 83rd percentiles for 2008 admissions into the integrated program. This increase also seems to be reflected in the scores of overseas students interviewed for 2009. These improved GRE scores resulted in the IBMSGP admissions being second only to students admitted to the USC PhD program in mathematics among the sciences; naturally the mathematics doctoral students have extraordinarily high scores in the quantitative section of the GRE.

The NIH-PREP admits four or five under-represented minority students per year, as described in the article by Bert Ely. The program is designed to help minority students gain better credentials to enter graduate schools by allowing them to work in a biomedical research environment for two years. These potential PhD students usually fail to enter graduate school immediately after earning a baccalaureate degree for a number of reasons, among which are low GRE scores and low GPAs. Although PREP scholars usually fail to obtain higher GRE scores after the PREP, they succeed in a number of other ways including in their GPAs. Thus, the IBMSGP has admitted minority students with less than stellar GRE scores in the hope that

such scores are not a predictor of success in graduate school. This hope has been borne out in that GPAs of the minority students in the first semester of graduate school are not significantly different from those of the other students in the IBMSGP.

Conclusion

The IBMSGP at USC is now entering its second year with an increased number of better qualified students being admitted and more faculty participation with a consequent greater choice of mentors and research projects. The program is already well-funded for the education of minority students through the PREP grant from NIH, grants from the Alfred P. Sloan Foundation and another NIH grant: The South Carolina Initiative for Minority Development. The challenge now is to obtain outside funding for the program as a whole. The IBMSGP has attracted the attention of the staff of the Centers for Disease Control in Atlanta, particularly because of its large minority participation. It is anticipated that a senior administrator from the CDC will work with the administrative staff of the IBMSGP in the pursuit of such funding.