

Perspective: A Proposal to Establish Master's in Biomedical Sciences Degree Programs in Medical School Environments

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Abstract

Most graduate schools associated with medical schools offer programs leading to the PhD degree but pay little attention to master's programs. This is unfortunate because many university graduates who are interested specifically in biomedical rather than pure science fields need further education before making decisions on whether to enter clinical, research, education, or business careers. Training for these students is done best in a medical school, rather than a graduate university, environment and by faculty who are engaged in research in the biomedical sciences. Students benefit

from these programs by exploring career options they might not have previously considered while learning about disease-related subjects at the graduate level. Graduate faculty can also benefit by being compensated for their teaching with a portion of the tuition revenue, funds that can help run their laboratories and support other academic expenses. Faculty also may attract talented students to their labs and to their PhD programs by exposing them to a passion for research. The graduate school also benefits by collecting masters tuition revenue that can be used toward

supporting PhD stipends. Six-year outcome data from the program at Newark show that, on completion of the program, most students enter educational, clinical, or research careers and that the graduate school has established a new and significant stream of revenue. Thus, the establishment of a master's program in biomedical sciences that helps students match their academic abilities with their career goals significantly benefits students as well as the graduate school and its faculty.

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Whenever I meet a student who is joining our master's program at the Newark campus of the University of Medicine and Dentistry of New Jersey (UMDNJ) and is not from the Northeast, I ask the student why he or she traveled so far to come to us: "Do you have family in the area or friends here in Newark?" Sometimes, the answer is yes, but more often the answer is neither. "There aren't any programs like this close to my home," they say. Home, in these cases, is California, Texas, Florida, Washington state, Michigan—in other words, most of the country. Master's degree programs in biomedical sciences (MBSs) can fill an important educational role, yet such programs are still relatively scarce. This should change. MBSs can be added to the current PhD curriculum in graduate schools associated with medical schools in a way that significantly benefits students, faculty, departments, and the local community.

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Traditional Views of Master's Degrees in Science Should Be Abandoned

Master's degrees in the sciences were once awarded as consolation prizes for students who could not make it through qualifying exams or who, for other reasons, were not considered suitable candidates for the PhD degree. This view began to change in the late 1990s when the Alfred P. Sloan Foundation and the Council of Graduate Schools anticipated the need for a professional science master's (PSM) degree as a terminal degree for students who wanted to work in science and mathematics but not necessarily at the level of the PhD.¹ This concept was originally tested in traditional areas, such as physics and mathematics, and in interdisciplinary fields, such as biotechnology and bioinformatics.² In fewer than 10 years, PSM programs have grown so that now more than 50 U.S. universities offer more than 100 different programs leading to PSM degrees.^{3,4} Recently, a study group of the National Academies of Science recommended a further acceleration in PSM degrees in the natural sciences.⁵ Unfortunately, the concept of PSM-style programs for those interested in biomedical science has not been embraced by most of the more than 120

medical-school-associated graduate programs in the United States. This is despite the remarkable growth in biomedical research funding during the last 20 years from NIH and private sources and the associated growth in jobs in these fields. Although universities are the best venues for pursuing higher degrees in many areas of science and engineering, students interested in biomedical fields and in health-related research are more effectively trained in a medical school environment.

MBS Programs Are a Logical Continuation of Undergraduate Education

Although some students transition directly from college into professional schools to pursue clinical careers or enter PhD programs with the goal of becoming research scientists, other talented and passionate science majors complete their undergraduate studies unsure of what they hope (and are qualified) to do professionally. Their undergraduate coursework usually is in biology, chemistry, physics, and, in many universities, biochemistry and molecular biology, but their studies are not directly related to careers in the biomedical sciences. MBS programs can educate these students in the biomedical sciences

and, through creative coursework, laboratory exposure, and internships, help them choose their career paths.

MBS Programs Benefit Wide Segments of the Campus Community

At the Newark campus of UMDNJ, we have developed an MBS program that meets the challenge of educating students to be qualified to join the biomedical workforce and that also helps students who are considering entering clinical careers and want to boost their knowledge and credentials in the biomedical sciences before applying to medical, dental, and other health professions schools. The popularity and need for this program is perhaps best reflected in its growth (Figure 1). In the 2008–2009 academic year, we received 376 applications and have matriculated about 150 students. Our medical (and, more recently, dental) schools have used applicants' performance in this program to determine whether some candidates who have the passion and aptitude for clinical careers, but have academic issues (e.g., a lackluster undergraduate GPA, a career change, marginal MCAT/DAT scores) can prove their academic abilities under conditions similar to those they would face as first-year medical or dental students. The MBS program has also benefited our PhD programs by introducing students to biomedical research laboratories and by helping them to make a more informed choice

about whether they want to commit to a PhD program. The MBS program has also rejuvenated many of our faculty by reintroducing them to the joy and satisfaction of teaching their areas of expertise to enthusiastic and intelligent young students. As a more far-reaching benefit, the program has enriched the cultural and economic life in Newark by bringing a new cohort of students to the area, many of whom live in local housing and volunteer in community outreach programs.

The MBS Program at Newark Follows an Interdisciplinary Curriculum

Our MBS program requires 30 credits (both day and evening courses are offered) that some students complete in 15 months (two semesters and a modified summer session) but that, more commonly, is completed in 1.5 to 2 years. The degree requires two didactic core courses (biochemistry/molecular biology and cell biology), a seminar course in which faculty present their ongoing research, and a 60-hour laboratory rotation to introduce students to active, modern biomedical research.

After the lab rotation, those interested in exploring careers in bench research but not necessarily to the PhD level (about 25% of the class during the past two years) can do a master's thesis as part of the program requirements. An MS degree is awarded to these students. We pay \$1,000 to laboratories in which students

perform their thesis research to help defray some of the research expenses. Most investigators report that the MS student is a welcome addition to their research group.

The remainder of the coursework is in any subject of interest to the student. Elective courses include histology, pathology, immunology, neuroscience, toxicology, and pharmacology and translational courses in cancer biology, molecular medicine of the heart, regenerative medicine, and neurobiology of disease. Many of these courses are medically oriented, specialized subjects that can best be offered in a medical school rather than a university setting. More than 25 new courses have been established in our graduate school since 1998, the majority to meet the needs of the master's program. Students planning to apply to advanced clinical professional schools may take a maximum of two classes in either the medical or dental school as part of their degree requirement. Other electives (e.g., bioterrorism, stem cell biology, clinical trials) reflect specific faculty members research interests and expertise. We also offer hands-on laboratory courses in human anatomy, current molecular techniques, and the appropriate use of animals in research. The latter two courses were developed primarily to meet the needs of students intending to enter the pharmaceutical/biotech industries.

Two separate internship electives, one in pharmaceutical companies (in accord with the goals of the PSM programs) and the second in science teaching at the high school level, are becoming student favorites. In the teaching internship, students enter local high schools in Newark and assist science teachers in the classroom. This program is in its infancy, but already we have seen indications of its efficacy for all those involved. High school students benefit from the mentoring by our students, and our students benefit by getting much-needed teaching experience. In addition, the high school teachers learn about modern medical issues (e.g., stem cell biology, molecular biology of the heart, current issues in cancer biology) by allowing our students to take over some classes and explain what they are learning in the MBS program.

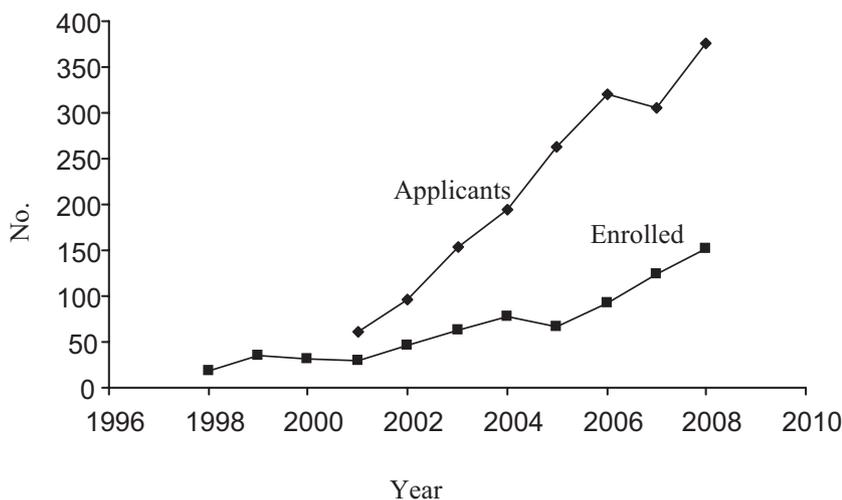


Figure 1 Applications and enrollment to the master's program at the Newark campus of the University of Medicine and Dentistry of New Jersey since 1998. Applications received before 2001 were fewer than 50 per year.

Our Faculty Have Embraced the MBS Program

Before starting this program, our faculty were similar to most medical school faculty in that their teaching responsibilities were in the medical (or dental) schools and the PhD program, but they shied away from teaching master's students and offering any extra courses. This has changed, thanks to the MBS program. The transformation has occurred in part because we have incentivized faculty by placing 30% of the MBS tuition revenue income in their discretionary university account (e.g., a three-credit course with 20 students would put approximately \$9,000 in the faculty account). However, many faculty have also rediscovered their love of teaching graduate courses in which, unlike medical school courses, they control the curriculum. Some of our teachers are experienced educators who have limited funding for their research and, thus, are able to devote more time to teaching. In many cases, the revenue received from teaching has helped keep their labs active. In several of our courses, the students who have finished the course have become active researchers in the teaching faculty's labs, either as part of the two-credit lab rotation or as a thesis student. Several faculty have kept a continuous flow of masters students as lab assistants, paid technical help, and thesis students since the inception of the program. Other faculty have active research labs and choose to participate in the teaching program for purely educational reasons. For example, one faculty member with an active research laboratory had for some time envisioned offering a course that follows drug development from discovery in a basic research lab to market. He has used the MBS program to develop this course that he teaches with a member of the pharmaceutical industry. This course is fully subscribed with both master's and PhD students. Another faculty member with an extremely productive research program decided in 2001 to offer a course in stem cell biology. Since then, she has developed three additional courses in the subject, a journal club in which current papers are discussed and then posted on the Web in lay and scientific summaries, and classes in hematopoietic stem cells and cancer stem cells. These courses are all fully subscribed, and we now offer a certificate in stem cell biology. The

certificate requires 15 credits, including the courses above and courses in biochemistry/molecular biology and in cell biology. Speaking about her cancer stem cell course, this faculty member said to me, "I need to learn more about cancer stem cells. I think the best way is to offer a journal-club-type course for those who have taken the other courses, and then we'll all learn together." The course has enrolled more than 50 students during the past two years. Students completing the certificate program have followed several career paths: Some are in (or have entered) medical school, others have gone on to a PhD program, and still others were either in industry when they registered for the program or have since gotten positions in industry as research technicians. Certificate programs in pharmacology, bioinformatics, and bioterrorism are also available.

Close Mentoring Is an Essential Component of the Program

While I was director of the MBS program, my office was not in a central administrative complex but in the pharmacology/physiology department with no secretaries or other impediments to student access. This allowed students the opportunity to come by, look in, and ask, "Are you busy?" The questions with which they approached me ranged from course selection, to career goals, to advice on internships, to what kind of laboratory research they should pursue, to volunteer positions. Each visit usually lasted no longer than 10 minutes, yet I have found that this contact has been an invaluable part of the success of our program.

Students from excellent undergraduate universities frequently have little appreciation for what goes on in a biomedical research lab and need guidance. Students also need objective advice about their chances for entry into professional school, and they need to know alternative options for clinical careers. Most students know little about the difference between allopathic and osteopathic medicine or what a physician assistant does, and many are unaware of the career opportunities available in a pharmaceutical or biotech company. For those students who came to me unsure of their career paths, I asked them to use the first six months in the program to consider whether they wanted to enter a

clinical career, a bench science career, business, or education. A recent graduate who entered osteopathic school after completing our program wrote me a wonderful note to tell me how happy she was about her choice and thanking me for all the help I gave her in choosing her career path. She added that although she had attended three different schools before coming to us, she had never experienced such personal attention. After reading the note, I thought back about our meetings—we probably met four or five times during 1.5 years, and each meeting lasted 5 to 10 minutes. A relatively small investment of time certainly yielded a rewarding outcome for this student and others like her. The expansion of the program (discussed below) has led us to recruit several additional faculty members to participate as advisors so that the personal attention of faculty advisors to students remains an essential element of the program.

The Outcome Data Are Encouraging

The MBS program at Newark was originally planned as a degree-granting program that would give students the course work, lab experience, and time to make more informed decisions about their career path. Unlike postbac programs, which are focused on preparing students to apply to medical school, the more varied coursework and electives help our MBS students prepare for other biomedical careers in addition to clinical medicine. We have examined the outcome data of 237 of our students graduating between 2000 and 2007 (Figure 2). Of the 197 students we have been able to track from this cohort, more than 50% have been successful in pursuing higher degrees leading to clinical careers (allopathic and osteopathic medicine, dentistry, veterinary medicine, physician assistant, nursing, clinical trial nursing). Others (about 9%) have discovered a passion for research and entered a PhD program. Another ~25% have used the program as a terminal degree and are employed in the pharmaceutical/biotech industry. These graduates have told us that their background in the lab, in lab techniques, and in handling animals was critical in obtaining a position and in being offered a higher salary than those applying without a master's degree (this is consistent with data reported recently in

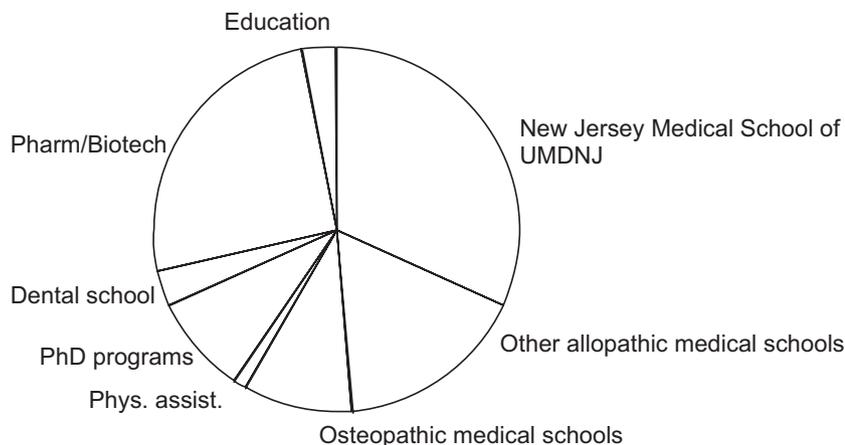


Figure 2 Postprogram pursuits of master's graduates from the Newark campus of the University of Medicine and Dentistry of New Jersey (UMDNJ) through January 2007. "Pharm/biotech" indicates students who either were employed in pharmaceutical/biotech companies while attending the program or who obtained positions on completion of the program.

Science Professionals: Master's Education for a Competitive World).⁵ Other graduates have obtained positions as science educators in area high schools, and still others have pursued occupations we had not envisioned when developing this program (e.g., investment analyst for emerging pharmaceuticals at a financial institution).

With our increased enrollment between 2001 and 2008 (Figure 1), there has been a significant increase in tuition revenue, to more than \$2 million in the last fiscal year. These funds, distributed among the teaching faculty (30%), departments (30%), and the graduate school (40%), help chairs meet their departmental graduate-training-related expenses, allow faculty to maintain their research labs or pay for other academic expenses (computers, travel, etc.), and help the graduate school support the PhD training program. Although the benefits to faculty and the graduate school are significant, it should be remembered that the main beneficiaries of this program are the students. Students enter the masters program frequently not knowing how to apply their undergraduate education and passion for biomedical science and usually end the program with charted career paths.

The growth of our program has also led to some new challenges. When this program began, we had a fairly even distribution of applicants: Approximately one third were interested in attending medical school and joined the program to enhance their academic credentials, a second group were from industry (or trying to get positions in industry) and sought a master's degree to enhance their educational status, and a third group were interested in the biomedical sciences but were not quite sure what career path they wanted to pursue. During the past several years, that profile has shifted, with now an estimated 80% or more applying to the program because they want to enhance their academic record so that they will be more competitive in their application to medical or dental school. We are seeking ways to help restore the balance so that the program remains a true master's program and not one geared only to those pursuing medical or dental school. The growth of the program also has led to an increase in the size of some classes (required classes now have more than 100 students—too many, we believe, for a graduate course) and the need to develop new electives or, perhaps, conduct current classes more often than once during an academic year. Faculty

associated with the masters program are currently addressing these issues.

Graduate Schools Associated With Medical Schools Should Consider Offering MBS Degrees

Undergraduate life science majors who do not immediately pursue doctoral degrees after graduation need our help in deciding on their career path. They need further specific education in the area of biomedical science—training that they are less likely to receive in university master's programs—and they need guidance as to what is available for them to do with this training. Master's programs in medical school environments are the appropriate places for this academic training. I urge the leaders of graduate schools associated with medical schools to consider the kind of masters program that best suits the needs of the students in their geographic region and that also fits their faculty's talents and to discuss the possibility of developing an MBS program on their campus.

Disclaimer

The opinions expressed are the author's own and do not represent the opinions of the University of Medicine and Dentistry of New Jersey, the New Jersey Medical School, or the Graduate School of Biomedical Sciences.

References

- 1 Professional Science Master's. Background on the PSM initiative. Available at: (<http://www.sciencemasters.com/PSMOverview/BackgroundonthePSMInitiative/tabid/72/Default.aspx>). Accessed December 2, 2008.
- 2 Kumagia J. Education for science and technical careers—New masters degrees. *Physics Today*. 1999;52:54–55.
- 3 Teitelbaum MS, Cox VT. A degree of professionalism. *Nature*. 2007;445:458.
- 4 Council of Graduate Schools. The Professional Science Master's Degree. Available at: (http://sciencemasters.com/portals/0/pdfs/PSM_Pilot_Study_FINAL.pdf). Accessed December 2, 2008.
- 5 National Academy of Sciences, National Research Council. *Science Professionals: Master's Education for a Competitive World*. Available at: (http://www.nap.edu/catalog.php?record_id=12064). Accessed December 10, 2008.