



**2003 PAESMEM Award Application  
The American Physiological Society**

**Nomination written by  
Marsha Lakes Matyas, Ph.D.  
APS Education Officer**

**Project Summary**

Professional societies play a key role in the professional development of students as well as an important leadership role in helping the research community become an active participant in K-12 science education reform. Additionally, they can serve as a catalyst in developing a scientific workforce that not only encompasses, but embraces the benefits of diversity among scientists.

This nomination describes the work of The American Physiological Society (APS), a professional society that has worked since the 1960s to increase diversity among physiologists by: monitoring the progress of minorities in the field of physiology; developing long-term targeted programs for minority students and teachers; and developing policies and procedures that assure that non-targeted APS programs involve diverse participants.

Each APS initiative launched is:

- Developed with consideration of how to attract diverse applicants to the program;
- Formatively evaluated to determine whether diverse applicants are applying for and successfully gaining entrance to the program or activity;
- Summatively evaluated to determine the impact of the program on all participants with a special focus on diversity issues; and
- Further developed to build viable connections between and among the individual efforts.

The resulting set of programs and activities are powerful both in their educational scope and their contribution to our overall understanding of effective program models. In addition to the specific impacts of each program, they have broader impacts: They model a visible commitment to encouraging the full participation of minority students in science by providing effective program models that can be disseminated widely. The APS commits to each program financially to promote their long-term sustainability and impact.

The PAESMT award funding will be used to provide direct support for a minority graduate student in the field of physiology through the Porter Physiology Development Program.

## **Background and Rationale**

In 1994, the National Research Council emphasized the specific need to involve minority students in the research workforce:

*“...[T]he number of individuals from racial and ethnic minority groups is increasing but not as fast as might be expected given federal efforts to encourage the participation of minorities in this area. The work force of the future will consist of an increasing proportion of women and minorities; it is important that these changes are reflected in the biomedical and behavioral science work force (1994, p. 11).*

Unfortunately, progress in increasing the representation of minorities<sup>1</sup> in science continues to be slow. The numbers of minority students earning degrees in the life sciences remain small, especially when compared to their increasing representation in the overall population. The percentage of bachelor degrees in biological sciences awarded to underrepresented minorities has increased only moderately, from 8% in 1977 to 14% in 1998 (NSB, 2002). Graduate enrollment of underrepresented minority students in biological sciences also rose little in the 1990s, from 6% in 1993 to 8% in 2000 (NSF, 2002). Similarly, the number of biological sciences doctoral degrees awarded to minorities only rose by 2%, from 5% in 1991 to 7% in 2000 (NSF, 2000, 2001). The number of degrees awarded to Native Americans remains less than 20 per year, less than 1% of total degrees for all biological sciences fields.

With the numbers of minority students working toward and completing doctoral degrees in life sciences so small, it is imperative that efforts be made both to recruit additional students into the field and to assure that minority graduate and postdoctoral students in life sciences are supported, have access to exceptional professional development opportunities, and successfully make the transition to postdoctoral and professional positions.

### **Critical Impact Points**

There are numerous studies and reports detailing the key factors leading to the underrepresentation of women and minorities in science (see, for example, Clewell, et al., 1992; Dix, 1987; ETS, 1992; Pearson & Fechter, 1994; Matyas & Malcom, 1991; Tack & Patitu, 1992; Tapia, 2001). The factors are both personal and systemic and include differences in precollege education and experiences and lack of financial support, adequate mentoring, knowledge about science careers, development of professional skills, and overall expectation that women and minorities can succeed in these fields. Because the reasons are diverse, efforts to increase the representation of women and minorities must be multifaceted, involve multiple partners, and utilize a long-range approach. There is no single solution that will increase the diversity of the scientific research community overnight. Rather, it will require a long-term effort where educators, researchers, professional societies, federal and state agencies, and private foundations focus effective strategies on critical impact points, that is, important steps in educational transition and progress where minority students are often lost from the science career path.

### **Cultural Issues**

An atmosphere that provides not only excellence in scientific training but also attention to important cultural issues is especially important for minority students. A

---

<sup>1</sup> Underrepresented minorities in science generally refers to African-Americans/Blacks, Hispanics (including Puerto Ricans, Mexican Americans, and Other Hispanics), and Native Americans/American Indians/Alaskan Natives.

study of NSF Minority Science Graduate Fellows found that, in every field, fellows who had received their undergraduate training at historically Black colleges and universities (HBCUs) completed their degrees at a higher rate (54%) than did comparable minority fellows from other types of institutions (37%). The study concluded "...the climate of support provided by HBCUs during the undergraduate training period provides a strong foundation for success in graduate training" (Baker, 1995, p. 30). Brown (2002) found similar results concerning the success of Hispanic undergraduate science and engineering honors students attending Hispanic-serving institutions.

Davidson & Foster-Johnson (2001) found that climate and mentoring are important factors at the graduate level as well for minority students. They point out that mentoring can enhance students' sense of self and social relations and can develop career skills by "...providing access to career-related services, particularly through opportunities that enhance skills and personal contacts" (p. 552). However, they also found that mentors often lack an understanding of the experience of students from various cultural backgrounds, a critical component in successful mentoring. Similar results were found in the 1995 National Research Council study, *Reshaping the Graduate Education of Scientists and Engineers* (NRC, 1995).

### **The Role of Professional Societies**

Professional societies play a key role in the professional development of undergraduate, graduate, and postdoctoral students. They also play an important leadership role in helping the scientific research community become active members of the K-12 science education support network. At the K-12 level, partnerships between K-12 educators and students and the research community have proven positive effects on the quality and quantity of science education. At the undergraduate level, student involvement in research projects, as well as faculty involvement in ongoing professional development, contribute to both an enhanced undergraduate experience and increased interest in research careers.

At the graduate level, the U.S. Congress Office of Technology Assessment cited "acculturation to the research environment" as a key factor in graduate education (1988). In a 2001 study of factors affecting minority students' decisions of whether or not to pursue doctoral studies in science, weaknesses in advisement practices and systems were found to be important factors. The authors strongly recommended "...early socialization of youngsters into the world of science and its practice" (Brazzeil & Brazzeil, 2001, p. 273). Unless students are welcomed into the culture of science and develop not only the research skills but also professional skills and networks, their chances of success are limited. Professional societies provide access to professional networks by providing opportunities for student-researcher interactions, orienting students to the meeting sessions and opportunities, and showcasing the work of students via meetings and publications. In addition, they can facilitate the development of support networks between students that can later develop into life-long networks of colleagues in the field. In many cases, professional societies can provide important information, networking, and resources that may not be provided by the student's mentor.

Unfortunately, professional societies are not always attuned to the cultural diversity of the students in their fields. They often assume that students are aware of and

comfortable with the cultural norms of the typical scientific meeting and the unwritten procedures for oral and poster presentations, seminars, and working with reviewers and editors. This assumes that the student's advisor has worked with him/her to develop these skills and become comfortable with the "culture" of scientific research in the U.S. Yet the above review of literature suggests that this often is not the case.

Professional societies can serve as a catalyst in developing a scientific workforce that not only encompasses, but also embraces the benefits of diversity among scientists. Specifically, they can monitor the progress of minority students and professionals in their field; create a supportive climate in society-sponsored meetings and programs; and create targeted programs for minority students that address the critical impact points identified above. **This nomination describes the work of an established professional society that has worked since the 1960s to increase the diversity of scientists in its field through these three areas and continues to seek opportunities to contribute not only through its own activities, but also by providing models for use by other organizations.**

### **The Organization**

The American Physiological Society (APS) is a non-profit professional association of scientists founded in 1887 and devoted to fostering scientific research, promoting excellence in education, and disseminating scientific information. The APS membership of approximately 11,000 includes Nobel laureates and members of the National Academy of Sciences. The APS is governed by an elected Council of nine members. Management of the affairs of the Society is the responsibility of a full-time Executive Director, Martin Frank, Ph.D., appointed by and responsible to the Council. The Society maintains a staff and offices on the campus of the Federation of American Societies for Experimental Biology in Bethesda, Maryland. Currently, the Society publishes 15 journals, holds several scientific meetings annually, and maintains an active public affairs program. In education, the APS supports a broad range of programs, from professional development programs for elementary teachers and day care providers to continuing education opportunities for physiology researchers. APS education programs are under the direction of Marsha Lakes Matyas, Ph.D.

**This nomination of the American Physiological Society for a Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring does not focus on an individual program or activity.** The APS has taken a much broader and comprehensive approach to both improving K-12 life sciences education for *all* students and to increasing diversity in the field of physiology. **Instead of scattershot, isolated efforts, the APS has worked since the 1960's to systematically address issues of diversity throughout its educational activities, through a combination of targeted programs and specific policies and procedures in non-targeted programs.** The Society's efforts to further improve and evolve its approach and programs are ongoing. The APS regularly seeks feedback from participants and uses evaluation results to improve its efforts and further impact the diversity of physiologists in both research and education.

There is strong research support for using a systemic approach to these issues. In the 1991 study, *Investing in Human Potential*, Malcom described the critical evolution of intervention programs as moving from *isolated projects* to *centers* that coordinate multiple efforts and, ultimately, to *structural reform* where "...the regular support of

departments and programs provides mechanisms to support the achievement of all students committed to education in science and engineering” (p. 145). This is the ultimate goal of the APS programs and activities. The text below describes the overall approach of the Society at each level and provides examples of both targeted and non-targeted programs that contribute to the effort.

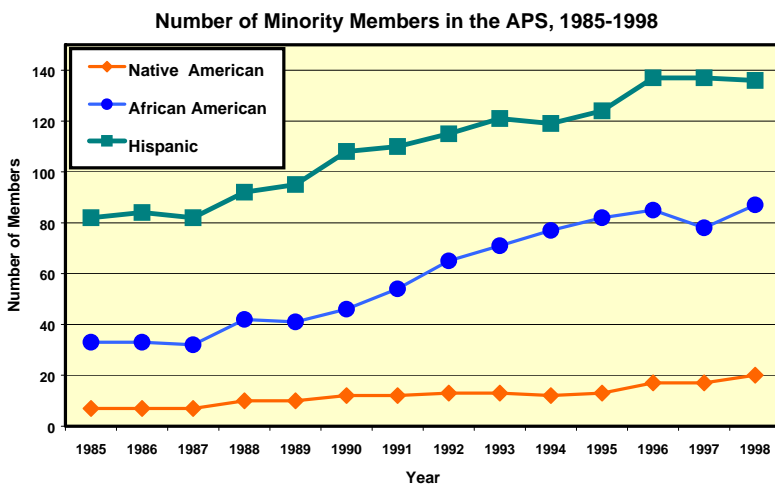
## Graduate and Postdoctoral Efforts

In graduate and postdoctoral education, APS programs concentrate on monitoring progress and on critical impact points such as transition to graduate work, graduate/postdoctoral retention, and transition into professional positions. They capitalize on the strengths of a scientific professional society and complement the efforts by individual physiology departments to promote diversity among physiology researchers.

### Monitoring the Status of Minority Physiologists (1994-present)

The APS actively monitors the participation of minority students in physiology degree programs, primarily graduate programs, and the participation of minorities in both its membership and in physiology careers. In 1995 and 2002 the APS analyzed data provided by the AAMC on the representation of minorities in physiology at U.S. medical schools. Matyas and Frank (1995) found that only 2-3% of physiologists were from underrepresented minority groups. This increased only slightly to 4% by 2002 (Frank & Matyas, 2002). They also found that, from 1976-1987, minorities earned only 2-3% of the physiology Ph.D.s awarded by medical school. After 1988, that percentage rose to 4-6% annually (Matyas & Frank, 1995).

In 1996, the APS conducted its first annual survey of physiology doctoral recipients (Matyas & Frank, 1998). Among the 261 students earning doctorates in physiology in 1995-96, 185 students responded to the survey. About a third of the respondents were women, but only 8% were minority students.<sup>2</sup> Among 1996-97 degree recipients, minorities accounted for 9% of degrees awarded (Matyas & Frank, 1999). The survey is now conducted online bi-annually; recent data are under analysis for publication.



The number of APS members from under-represented racial/ethnic groups doubled between 1985 (N=122) and 1998 to 244 members (see Figure at left).<sup>3</sup> This can be partially attributed to aggressive recruitment of minority students who participate in APS programs. In 1987, the APS initiated the minority travel fellows program and has increased its minority membership, particularly

among Hispanic and African American physiologists, in most subsequent years.

<sup>2</sup> Native American, African American, or Hispanic.

<sup>3</sup> In 1999, categories and survey methods were changed; therefore, 2000-2002 data are not directly comparable.

**Sustainability:** NSF provided initial support for the annual survey of doctorates. Since 1999, the APS has fully funded the survey.

**Porter Physiology Development Program (1967-present)**

The Porter Physiology Fellowship program focuses on encouraging diversity among students pursuing full-time studies toward the Ph.D. (or D.Sc.) in the physiological sciences. Fellowships are open to underrepresented ethnic minority applicants who are citizens or permanent residents of the United States or its territories (African Americans, Hispanics, Native Americans, Native Alaskans, or Native Pacific Islanders). Porter Fellowships are one-year awards that may be renewed for a second year. Fellows are selected by a panel made up of members of the Society, the Porter Physiology Development Committee, currently chaired by a past Fellow, Dr. Pamela Gunter-Smith, Chair of Biology at Spelman College.

**Program Impacts:** The number of minority predoctoral and postdoctoral fellows who were supported annually by the Porter program grew from one per year in 1967 to nine per year in 1990. Awards have been made to a total of 73 fellows. In 2000, with support from the NIDDK, the APS began a follow-up study to determine the impact of the program. Results of the study are summarized below.<sup>4</sup>

About a third of the responding Porter Fellows were still completing their doctorate (20%) or in postdoctoral positions (14%). Nearly two-thirds (64%) were working in professional positions as physiologists. Only one of the Porter Fellows (2%) did not complete a doctoral degree. Data on non-respondents were gathered from the Internet and other sources. Virtually all of the past Porter fellows were working in science or science administration in academia, government, or industry. Among those employed, most were in a variety of academic positions. Many were in tenured or tenure-track positions. Those who held positions in government or industry tended to be in significant managerial or administrative positions. For example, government employees included the head of an NIH institute and deputy directors of an NIH center and an NSF division. Industrial positions included a director of international regulatory affairs. More than half of the employed fellows spent at least a portion of their time in research, three-quarters spent at least a portion of their time engaged in teaching, and two-thirds allocated time to management/administration.

Fellows also commented on the impact that the program had on their careers. Comments were overwhelmingly positive, emphasizing the role of the fellowship in their own careers and those of their students. Two Fellows summarized their thoughts in the following way:

*This prestigious award played a critical role in defining my career path as a physiologist, both as a teacher and a researcher. It increased my commitment and devotion to the physiological sciences because I became part of a selected and highly distinguished group of scientists that defined the knowledge and direction of what constitutes physiology today.*

*I was always told by my colleagues that I would be a good role model to minority students. Having fellowships like the Porter Development Fellowship insures the training of minority professionals. Young minority students can have hope of becoming scientists when they see those of us who have made it. I have graduate*

---

<sup>4</sup> A full copy of the evaluation report can be accessed at <http://www.the-aps.org/education/eval.html>

*students who tell me that they want a laboratory and to do research like I am doing which makes me feel that I have accomplished something.*

Past and current Porter fellows are invited to a special annual reception in their honor at the APS annual meeting, *Experimental Biology*. The reception serves to help build connections among minority scientists in the field of physiology.

**Sustainability:** The APS provides an annual contribution of \$40,000 plus all staff, administrative costs, and overhead. The William T. Porter Foundation, industrial foundations, and private individuals contribute significant funding for fellowships.

### **Minority Travel Fellows Program (1987-present)**

The goal of this program, supported by the National Institute for Diabetes, and Digestive and Kidney Disorders (NIDDK), is to encourage minority students to pursue professional careers in the physiological/biomedical sciences. Specifically, the program provides travel fellowships to undergraduate, graduate, and postdoctoral minority students to attend the annual spring meeting, *Experimental Biology* (EB), and the APS fall conferences.

However, the Fellowship is not simply reimbursement of travel expenses. The program is designed to enrich the meeting experience and to build connections between and among minority students and experienced physiologists. Each fellow is hosted at the meeting by a mentor, an APS member who is in a similar research field and has volunteered to host the student and enrich their meeting experience. At EB, Fellows attend an opening orientation session with their mentors and the Porter/Travel fellows opening reception, and are honored at a luncheon at the end of the meeting. An email listserv recently has been established to further facilitate communication between and among students and researchers in the program.

Travel fellowships are also available for faculty members at Minority Access to Research Career (MARC)- and Minority Biomedical Research Support (MBRS)-eligible institutions. These fellowships are designed to help faculty stay current on both scientific content and on research methods. Faculty members often apply along with their undergraduate students. Support is also provided for minority students to attend the fall conferences of the APS. These three- to five-day meetings are focused on a specific physiology topic and occur in an informal setting, allowing for greater interaction between the students and scientists at the meeting. Graduate students who have been Porter or Travel fellows are invited to attend a Summer Retreat with teachers from the Summer Research Program (see below). The program sponsors these graduate and postdoctoral students to visit classrooms of minority middle and high school students (see Martin Farias' letter in Appendices)

**Program Impacts:** The APS-NIDDK Minority Travel Fellows Program has supported more than 450 fellows. Most awardees are graduate students. Somewhat fewer awards are made to postdoctoral fellows and the smallest number is awarded to undergraduate students engaged in physiology research. Many students have received multiple travel awards, allowing them to regularly attend and present at APS conferences throughout their training as well as build a network of colleagues and contacts. The program is evaluated for short-term impact by exit surveys completed by fellows at the end of each scientific meeting attended. Results of the post-meeting

evaluations are consistently very positive.<sup>5</sup> For example, 2001-2002 Fellows (N=44) gave very strong ratings to the meeting sessions they attended and to their interactions with mentors. When asked whether they would recommend participation in the program to others, 100% of the awardees said, "Yes." Student comments on the exit forms were extensive, offering both positive comments and suggestions for program expansion and improvement. One student's comment summarized many of those made by other students:

*The mentoring program has been essential for my career and my experience at EB [Experimental Biology]. My mentors have offered essential feedback on life goals and my research. I have become good friends and colleagues with people in the program. I wish everyone were able to use this type of program.*

The long-term impacts of this program are currently being assessed via a survey of all past participants; results of this assessment will be completed in 2003.

**Sustainability:** Support for student travel is provided by a grant from the NIDDK. The APS provides all staff, administrative, and overhead costs. In 2000, the NIDDK provided additional funds for evaluation of the Travel Fellows and Porter programs.

### **APS Career Web (2003)**

In February 2003, the APS launched a new career web that provides an array of resources for students at different grade levels who are interested in exploring careers in physiology. Appropriate resources are provided for students at the elementary, middle/high school, undergraduate, graduate, and postdoctoral levels. Resources sections are also provided for new investigators, established investigators, and the general public. The site can be viewed at <http://www.the-aps.org/careers.htm>. For graduate students, the site provides information on career resources (both at the APS site and at dozens of other web sites), fellowships and awards, meetings, biographies of diverse physiologists, positions available, and links to the APS Mentoring Program website (where students can connect with a mentor from another institution).

In addition to the types of resources listed above, at each educational level, additional resources are provided for minority students and scientists on "Minority Resources" pages. These pages do not reiterate the other resources but, rather, provide additional resources and links of particular interest to minority students and their mentors (e.g., links to the organizations, programs, fellowships/scholarships, resources for educators, links to minority scientist biographies, etc.).

**Sustainability:** The APS fully funds the development and maintenance of the web site.

## **Undergraduate Efforts**

At the undergraduate level, APS programs concentrate on the critical impact points of undergraduate recruitment and retention, as well as on improving undergraduate science education, overall.

### **Undergraduate Recruitment and Retention**

The undergraduate years are a critical point in the training of a future scientist. The rigorous study required by a science degree necessitates a strong career commitment on the part of the student. Most reports on undergraduate science education

---

<sup>5</sup> A copy of the most recent annual evaluation report can be viewed at <http://www.the-aps.org/education/eval.html>.

emphasize that early experiences that involve the student in the scientific process and community (e.g., undergraduate research experiences and presentations at scientific meetings) are important in developing and maintaining scientific career commitment. The APS programs support these early experiences in a number of ways.

**Undergraduate Minority Travel Fellowships:** As described above, the APS-NIDDK Minority Travel Fellowship program provides support for undergraduate students as well as graduate and postdoctoral students. The program has clear benefits for undergraduate students. In addition to the opportunity to present their research at major national meetings, students also begin to build their connections to researchers in the field through the mentoring aspect of the program. Another benefit for undergraduate students is a powerful role-modeling component. Through the travel fellowship program, they meet and interact with many minority graduate and postdoctoral students, both through the meeting and through the program listserv. Many students have commented in their evaluation forms that they were unaware that there were so many minority students already in graduate work in their field.

In addition to the NIDDK funds, additional funds from the Explorations in Biomedicine program (see below) provide fellowships for Native American undergraduate students from tribal colleges to attend APS meetings. Many of these students are just beginning to be interested in a research career. The Explorations support lets them explore this option further before beginning their research activities. As one tribal student pointed out, the opportunity to travel out-of-state is especially important:

*“EB is a motivating conference that allows me the opportunity to meet fellow researchers and faculty from institutions with my interest of academic advancement. It is also a luxury to be able to travel and experience other economies, geographies and social climates outside of Montana. The traveling alone has given me insight to the endless opportunities available to me as well as the diversity offered throughout the United States.”* (Female Native American Fellow)

**Technical Support for MARC, MBRS, and Bridges Programs (1997-2002):** The APS also played an important role in assisting MARC, MBRS, and Bridges programs to improve their programs through the use of program evaluation. In 1997, the Minority Opportunities in Research (MORE) division of the National Institutes of Health (NIH)/National Institute of General Medical Sciences (NIGMS), provided funding to the APS to develop resources and training materials for directors of MARC, MBRS, and Bridges programs that would enhance the quality of their program evaluations and, consequently, promote the development and continuation of effective MORE programs. The activities were designed to help project directors significantly improve their understanding of the benefits of program evaluation and the pro's and con's of internal and external evaluations as well as their skills in developing and implementing both formative and summative evaluation plans.

Project activities included a collaborative needs assessment, a series of four-day Evaluation Exploration Short Courses, workshops at MORE meetings, and a project newsletter, website, and listserv. In order to provide ongoing information and training on the development of program evaluation plans, the APS staff developed online and CD-ROM versions<sup>6</sup> of an evaluation exploration short course that incorporate many of the features, materials, and resources of the four-day short courses. Both the CD and

---

<sup>6</sup> <http://www.the-aps.org/education/promote/promote.html>

web course allow the user to create an evaluation planning document that includes the project's goals, measurable objectives, activities, and description. They also include resources such as links to evaluation websites, guides for finding and interviewing an external evaluator, and budget planning spreadsheets. The online course is provided as a free resource at the APS website.

The project had significant impacts. More than 350 MARC, MBRS, and Bridges directors and staff participated in the projects' short courses and workshops. Short-term workshop impacts were evaluated by pre and post surveys of short course participants; results indicate that the program was successful in meeting its objectives.<sup>7</sup> For example, prior to the short course, only 15% of participants rated their skills in program evaluation as "good" or "excellent." Following the short course, 58% felt their skills were "good" or "excellent." Long-term impacts were assessed by success rates of workshop participants in obtaining funding for MORE proposals developed subsequent to the workshop. Among proposals received by the MORE division in 1998-2000, 63% of the proposals submitted by persons who had attended a four-day short course received review scores leading to funding while 43% of proposals submitted by persons who had not attended received scores leading to funding. While this finding is correlational rather than causal, it suggests that the technical support provided by the APS contributed to the creation of competitive proposals for minority recruitment and retention programs.

**Sustainability:** Initial support for the program was provided by NIGMS; the APS provided partial overhead costs (13%). Starting in 2003, the APS will cover all costs for maintaining the website.

**APS Undergraduate Summer Research Program (2000-present):** Recognizing the importance of undergraduate research experience to a later career in physiology research, in 2000 the APS Council approved funds to develop and support summer research fellowships for undergraduate students. These fellowships support full-time undergraduate students to work in the laboratory of an established physiologist.<sup>8</sup> The intent of the program is to excite and encourage students to pursue a career as a basic research scientist. Although this is not a program targeted specifically for minority students, it was developed in line with APS' overall diversity efforts. Therefore, recruitment includes a focus on reaching minority students who may be interested in a research career (e.g., via MARC, MBRS, and Bridges programs) and in encouraging the selection of diverse students for the fellowship. As a result, of the 36 fellows selected in the first three years of the program, 9 (25%) are from minority groups underrepresented in science. As the APS' newest fellowship program, it was especially encouraging that, from the inception, the design of the program and the plan for publicity allowed it to attract a significant number of minority applicants.

**Impact:** As in the other APS programs, ongoing evaluation and feedback allow for further fine-tuning of the program policies and procedures. Fellows complete an entry and exit survey and, in 2003, the first follow-up surveys of the 2001 participants will provide opportunities to keep in contact with and assess the career progress of the first year's fellows. Minority students participating in the first two years of the program reaffirmed in their exit surveys that they were committed to a career in research.

---

<sup>7</sup> A copy of the evaluation results can be accessed via <http://www.the-aps.org/education/eval.html>

<sup>8</sup> <http://www.the-aps.org/education/ugsrif/index.html>

When asked whether they had gained anything from their research experience, students were very positive:

*First, I have come to understand the dynamics of insulin receptor processing. But more importantly, I have begun to develop analytical and explorative thought. I have learned how to approach and solve practical problems.* (2000 Fellow, Hispanic, male)

*I have gained a lot of confidence by proving to myself that I can produce quality work in a lab. I've learned how much work research can involve but that in the end it is a rewarding experience.* (2000 Fellow, Hispanic, male)

*I find myself very familiar and comfortable with not only the lab itself but also with the extra things that come with doing good research, i.e., writing reports, grants, and presenting. Additionally, I gained the best mentors who will continue to remain my top mentors.* (2000 Fellow, Hispanic, female)

*Before starting this experience, I had already realized that I really enjoyed research. This experience has strengthened my interest for basic science research even more and has motivated me to pursue my career goals. It has reassured me that what I would like to do, and enjoy doing, is basic science research...Besides the new lab skills and techniques, which are the basic tools necessary for any investigation, this experience has allowed me to become fully aware of the whole research process.* (2001 Fellow, Hispanic, male)

**Sustainability:** The APS funds the program in its entirety.

### **Enhancing Undergraduate Science Education**

The APS also has targeted and non-targeted initiatives to enhance undergraduate science education, especially at institutions with high minority populations. These are described below.

#### **Explorations in Biomedicine: Native Americans & Research Careers (1996-present)**

The overall goal of Explorations is to strengthen the science education programs at Native American-serving educational institutions in Montana and, consequently, to increase student interest in and access to biomedical research careers. The project's specific objectives are to:

**Build effective working relationships** between and among educators and students at institutions serving Native Americans and physiology researchers across the nation;

**Improve undergraduate and precollege science education** at these institutions by promoting the implementation of content and pedagogy recommended by national standards projects;

**Increase access to print and online resources on science education and biomedical research careers** for faculty at these institutions; and

**Increase faculty skills in identifying, developing, assessing, and utilizing web-based curricular materials and resources** in science education.

The program includes summer research fellowships for tribal college faculty and middle and high school teachers at schools serving Native American students. Fellows engage in biomedical research with APS members nationwide and build working relationships with both researchers and fellow teachers. The program also includes weekend retreats and one-day workshops for science educators from Montana. Retreat

topics have included: “Teaching Physiology – Low Tech to High Tech”; “Native American Issues in Biomedicine”; “Teaching and Learning by Inquiry”; and “Online Resources for Science Education”. The project also created and disseminates a free CD of science teaching resources for Native American classrooms.

**Program Impacts:** The Explorations in Biomedicine program, now in its sixth year, has had a strong positive impact on science education in the area. The following is an excerpt from the 2000 external evaluation report (Clewell, 2001):

*One of the goals of the [summer] program is to expose Montana educators to the research process and to facilitate the transfer of the knowledge thus acquired to their classrooms...Summer participants overwhelmingly responded that having a better understanding of the research process had helped them to incorporate elements of research in their classes and, especially, in their laboratory sessions. Some indicated that the experience had motivated them to pursue opportunities to conduct research on their own and to involve their students in this research.*

*The great majority of both groups [summer program and fall retreats] agreed that participation in the program helped them strengthen their teaching of the scientific method to their science classes, improved their content knowledge of physiology, and helped them become more knowledgeable about careers in biomedicine...There seems to be no doubt that participants in both groups perceived that the program had helped them develop a more inquiry-based, student-directed approach to teaching science. The great majority (almost 100%) agreed that the program had enhanced their understanding of inquiry-based learning and increased the amount of inquiry-based instruction used in their science classes. The vast majority also reported that having been in the program resulted in their trying to make lab sessions more student-directed...*

*One measure of program success in helping participants establish a support network is the percentage of Summer Research educators who have continued to maintain contact with their summer host...[A]lmost two-thirds (62%) of summer group respondents have kept in touch with their summer host, usually through e-mail or telephone. Half of those who have maintained contact have made visits to the summer host's institution or lab. Other forms of contact with the Summer Research host have included working on research projects, having the host visit teachers' schools, and presenting and publishing with the summer host...Both groups—but especially the Summer Research group—credited the program with having helped them to establish a support network made up of APS staff, other teachers, and researchers with whom they can share ideas...Overall, the findings of this evaluation lead us to conclude that the Explorations in Biomedicine program has been successful in achieving its goals.”<sup>9</sup>*

**Sustainability:** Program funds are provided by the NIGMS. The APS provides partial overhead costs (13%).

### **Physiology Insights: Faculty Enhancement Program (1996-2001)**

The Physiology Insights program provided summer research fellowships and faculty development workshops for faculty at 2- and 4-year colleges with a special focus on faculty who taught physiology but had limited background in this area. A focus on community colleges allowed the program to interact with many faculty members who taught primarily minority students in their courses. Five of the seven summer research fellows taught at community colleges with primarily minority student populations. These interactions also attracted faculty at minority institutions to apply for travel support from the Minority Travel Fellows program to attend APS conferences, including Experimental Biology. The program is currently being redesigned to provide

<sup>9</sup> A copy of the evaluation results can be accessed via <http://www.the-aps.org/education/eval.html>

faculty enhancement opportunities in conjunction with the new APS Archive of Teaching Resources<sup>10</sup> and the BiosciEd Net Digital Library<sup>11</sup> (both NSF-sponsored National Science, Technology, Engineering, and Mathematics Digital Library projects).

The Insights program was evaluated both by external evaluators and via internal evaluation.<sup>12</sup> The faculty enhancement workshops were especially effective. Follow-up surveys administered 9-12 months after the workshops showed that nearly 60% of the participants already had used the workshop labs/lessons with their students and half had used the physiology content information. Nearly two-thirds (65%) had already begun to employ the specific pedagogies modeled during the workshops.

**Sustainability:** NSF provided initial support for the program. Starting in 2000, the APS has covered all costs for continuing the workshops program.

### **K-12 Science Education Efforts**

At the K-12 level, APS programs focus on the improvement of science education by building research scientists and scientists-in-training into the support network for precollege education/educators. Major activities include the APS Summer Research Program, Local Outreach Team workshops, Explorations in Biomedicine, and My Health, My World, a collaborative elementary curriculum development program with Baylor College of Medicine.

#### **APS Summer Research Program (1990-present)**

In 1990, the APS launched a summer research experience program for high school teachers. Over more than a decade, the program has evolved and expanded into a highly effective, nationwide program, involving middle and high school science teachers in effective professional development activities, including:

- Summer research experiences that provide a unique inquiry-immersion experience;

- Inquiry-based curriculum development, including web-based materials;

- Mentoring and leadership roles for teachers;

- Materials and activities to promote adoption of the National Science Education Standards and state standards, with a special emphasis on inquiry-based teaching and learning, strategies to promote equity and support diversity in the classroom, and the effective use of Internet-based resources; and

- Network development with teachers and researchers nationwide.

*Frontiers* has produced an abundance of resources for educators, including more than 230 teacher-developed activities published in hard copy and more than 90 teacher-developed, inquiry-based activities published on the Internet. *Frontiers* has served as a model for professional organizations and research institutions and has provided materials and methods for individual teachers and in-service providers such as science departments and professional science associations, State Systemic and Urban Initiatives, state science supervisors, and regional education laboratories.

Most importantly, *Frontiers* is unique among professional development programs in its consistent outreach to minority teachers and teachers of minority students. As the

---

<sup>10</sup> <http://www.apsarchive.org>

<sup>11</sup> <http://www.bioscienet.org/>

<sup>12</sup> A copy of the evaluation results can be accessed via <http://www.the-aps.org/education/eval.html>

program developed, the participation of minority teachers and teachers of minority students was monitored and, by 1995, targeted efforts were made annually to increase the number of minority teachers and teachers of minority students applying to the program. Additional funds were solicited from the NIDDK to specifically fund 3-5 minority teachers each year, in addition to those selected during the regular application process. **As a result, from 1993-2002, nearly half (48%) of the teachers in the program annually, on average, have been from schools where well over 50% of the student body was from a racial/ethnic minority group underrepresented in science careers. In that same time period, on average 29% of the teachers in the program annually were from racial/ethnic minority groups.** The program's strong emphasis on equity and diversity issues and on building connections with local researchers has attracted significant numbers of minority teacher applicants to the program.

**Program Impacts:** *Frontiers* has been extensively evaluated over its long history. It consistently has strong positive effects on: the teaching methods used by teachers (that is, selecting more student-centered methods that build research and investigative skills), the networks built between and among teachers and researchers, and teacher perceptions of the value of biomedical research and how animals are used in research (Pasley, 1998; Dotterer & Pasley, 2000). The following quote from the most recent summative report summarizes the program's impact on Research Teachers (RTs):

*As a result of participating in the program, middle and high school RTs report a marked increase in both their confidence and enthusiasm for reform-oriented science teaching and their ability to grasp modern physiology science. Becoming more connected to the scientific realm and having the chance to enhance their content and pedagogical knowledge and skills affords RTs new avenues through which to enhance their science instruction. There have been concrete changes in their classroom practice, ranging from the addition of new content or infusion of new inquiry-based activities in their curriculum to the more effective use of a wider range of teaching techniques or an altered approach to how students are engaged in science (Dotterer & Pasley, 2000, p. 40).*



Isabelle Camille,  
1997 Research  
Teacher, Miami,  
Florida

**Personal Perspective:** *“Staying in close contact with the research world has not only kept my interest in science alive but also has been my greatest motivator to encourage my students to go into a scientific field. One of the most valuable lessons I learned during the APS summer research was not about physiology. It was the pure joy of doing scientific research. During the retreat week, we had a chance to reflect on our summer research project, the structure of our science curriculum, the teaching strategies we employed in our classroom and the goals we had in mind for our students. We shared our experiences in both the classroom and the laboratory. The brainstorming sessions and the guided reflections put you right there in front of your work, and forced you to come face to face with it and see what you’ve done and what you want to accomplish. I know I came back that year a much better teacher.”<sup>13</sup>*

**Sustainability:** Support for the Summer Research Program and the LOT program (below) has been provided by NSF and NIH. The APS contributes \$60,000 annually for teacher stipends and travel, workshop costs, APS memberships for teachers, the Advisory Board and PI meetings, and partial overhead costs (13%).

<sup>13</sup> Personal communication to M. Matyas, February 2002.

### **APS Local Outreach Team Program (1994-present)**

Local Outreach Teams (LOTs) are the grassroots arm of the Frontiers in Physiology program. LOTs disseminate life science teaching materials and resources to middle and high school life science teachers via inservice workshops and build connections between physiology researchers and local teachers and schools. Each Local Outreach Team is a collaborative of local middle and high school teachers with local research scientists and all workshops are led by the collaborative team. LOT workshops merge the strengths of the teachers (pedagogy and knowledge of the curriculum, state requirements, and school/classroom issues) with those of the researchers (up-to-date content knowledge and health information). In planning their workshop, each team must consider the diversity issues in their geographic area and how their team will address these issues in both the recruitment process and in the workshop content. To date, 28 LOTs have led workshops in more than 20 states. Well over half of these teams have targeted schools with primarily minority student populations.

**Program Impacts:** According to the external evaluation report (Dotterer & Pasley, 2000), the majority of middle and high school teachers who took part in the 1998-2000 LOT workshops,

*“...reported that they had gained skills in reflection, problem-solving, inquiry, and equity...The majority of participants...reported that they had improved their content knowledge in physiology and that they were better prepared to teach physiology concepts as a result of their participation. The potential for these teachers to use the physiology activities presented in their instructional program is promising; a large number of participants felt that the activities were appropriate for their middle or high school students and that they would be easily transferable to their classrooms” (p. 32).*

### **My Health, My World (1995-present)**

In 1995, the APS began a long-term collaboration with Baylor College of Medicine in the development, field-testing, and dissemination of curricular materials that integrate science (life, physical, health, and environmental) with reading, writing, and mathematics for students in grades K-5. Elementary educators eagerly seek this type of integrated material because it allows them to address multiple curricular goals within each lesson. The APS and Baylor have collaborated in the development of eight different units for grades K-7. Each includes stories, hands-on, inquiry-based science, mathematics integration, and writing opportunities. The materials developed have recently been adopted as a featured product by Carolina Biological Supply Company for national distribution.

APS' key role in this project was involving teachers of minority students from the Washington area. The input of teachers from diverse settings (including DC Public Schools, Montgomery County Schools, Gallaudet University's Kendall Demonstration Elementary School for children with hearing issues, home school providers, and summer camp/after school program directors, and day care providers) provided important information for the writers about creating materials that address students from different racial/ethnic groups, physical abilities, cultures, and strengths.

**Sustainability:** Grants to Baylor College of Medicine from NCRR and NIEHS have provided support. The APS contributes partial staff costs and all overhead costs (21%).

## A Systemic Approach

The American Physiological Society could be nominated for this award for several of its individual programs. The Porter Physiology Development Fellowships pre-date the well established MARC and MBRS programs. The Minority Travel Fellowship program has many mentor volunteers who were, themselves, student travel fellows when the program began. The Summer Research Program is one of the few national fellowship programs that involve a significant number of minority science teachers and teachers of minority students.

However, while each of these programs is an excellent example of professional society mentoring of the next generation of minority scientists, they do not individually describe the APS' distinctive organizational commitment to increasing the diversity of the scientific workforce. What sets the APS apart is the long-term commitment of the Society to strongly addressing diversity issues within **each** APS educational program. Each initiative launched is:

Developed with consideration of how to attract diverse applicants to the program;

Formatively evaluated to determine whether diverse applicants are applying for and successfully gaining entrance to the program or activity; and

Summatively evaluated to determine the impact of the program on all participants with a special focus on diversity issues; and

Further developed to build viable connections between and among the individual efforts to promote networking and collaboration among students, researchers, mentors, and educators at different educational levels.

When areas are identified that would benefit from efforts targeted specifically toward minority participants or issues, then specific programs are developed in those areas. The resulting set of programs and activities are powerful not only in their educational scope but in their visible commitment to encouraging the full participation of minority students in physiology and in improving science education for *all* students.

The APS also commits to each program financially to promote their long-term sustainability and impact. As noted after each initiative above, the APS uses a balance of internal and external funds to support its minority initiatives. The Society contributes direct costs, staff time, administrative costs, and overhead to many of its programs, even those with external support.



**Personal Perspective:** *“As a member of the APS for over 30 years and a Mexican-American, it has been extremely gratifying to see the development of a diverse collection of programs designed to enhance the participation of members of underrepresented groups in science in general and the physiological sciences in particular. I have also been an active member of the governing body of APS, serving as a member of both the Executive Council and as President of the Society. Because members of underrepresented minorities are less likely to have access to special pipelines, networks or role models, it is particularly incumbent on us to provide specific opportunities that attract these individuals to our disciplines.”<sup>14</sup>*

L. Gabriel Navar, Chair, Department of Physiology, Tulane University School of Medicine, APS Past-President, and founding member of the Society for the Advancement of Chicanos and Native Americans in Science

<sup>14</sup> Personal communication to M. Matyas, February 2003.

## References

- Baker, J. G. (1995). *Minority Science Paths: National Science Foundation Minority Graduate Fellows of 1979-1981*. Washington, DC: National Academy Press.
- Brazziel, M.E., & Brazziel, W. F. (2001). Factors in decisions of underrepresented minorities to forego science and engineering doctoral study: A Pilot study. *Journal of Science Education and Technology*, 10(3), 273-281.
- Brown, S. W. (2002). Hispanic students majoring in science or engineering: What happened in their educational journeys? *Journal of Women and Minorities in Science and Engineering*, 8 (2), 123-148.
- Clewell, B.C. (2001). *Evaluation of the Explorations in Biomedicine Program of the American Physiological Society: Final Report*. Washington, DC: Beatriz Clewell.
- Clewell, B.C., Anderson, B.T., & Thorpe, M. E. (1992). *Breaking the barriers: Helping female and minority students succeed in mathematics and science*. San Francisco: Jossey-Bass.
- Davidson, M.N., & Foster-Johnson, L. (2001). Mentoring in the preparation of graduate researchers of color. *Review of Educational Research*, 71(4), p. 549-574.
- Dix, L.S. (1987). *Minorities: Their underrepresentation and career differentials in science and engineering*. Washington, DC: National Academy Press.
- Dotterer, R.E. & Pasley, J.D. (2000, October). *New Frontiers in Physiology/Physiology Insights Final Evaluation Report*. Chapel Hill, NC: Horizon Research, Inc.
- Educational Testing Service (ETS). (1992). *Minorities in graduate education: Pipeline, policy, and practice*. Princeton, NJ: Educational Testing Service.
- Frank, M. & Matyas, M.L. (2002). The status of physiologists and physiology at U.S. medical schools. *The Physiologist* 45(4), 179, 184-192.
- Matyas, M. L. & Frank, M. (1995). Physiologists at U.S. Medical Schools: Education, Current Status, and Trends in Diversity. *The Physiologist*, 38, 1-12.
- Matyas, M. L. & Frank, M. (1998). The employment of recent doctoral graduates in physiology. *The Physiologist*, (41), 153, 156-160.
- Matyas, M. L. & Frank, M. (1999). Employment of 1996-97 Doctoral Graduates in Physiology. *The Physiologist*, (42), 117-122.
- Matyas, M.L. & Malcom, S.M. (Eds). (1991). *Investing in human potential: Science and engineering at the crossroads*. Washington, DC: American Association for the Advancement of Science.
- National Research Council (NRC) Committee on National Needs for Biomedical and Behavioral Research Personnel. (1994). *Meeting the nation's needs for biomedical and behavioral scientists*. Washington, DC: National Academy Press.

- National Research Council Committee on Science, Engineering, and Public Policy (1995), *Reshaping the Graduate Education of Scientists and Engineers*. Washington, DC: National Academy Press.
- National Science Board (NSB). (2002). *Science and Engineering Indicators – 2002*. Arlington, VA: National Science Foundation.
- National Science Foundation (NSF). (2000). *Women, Minorities, and Persons with Disabilities in Science and Engineering 2000*. (NSF 002-327). Arlington, VA: National Science Foundation.
- National Science Foundation (NSF). (2001). *Science and Engineering Doctorate Awards: 2000*. (NSF 02-305). Arlington, VA: National Science Foundation.
- National Science Foundation (NSF). (2002). *Graduate Students and Postdoctorates in Science and Engineering Fall 2000* (NSF 02-314). Arlington, VA: National Science Foundation.
- Office of Technology Assessment (OTA), U.S. Congress. (1988). *Educating scientists and engineers: Grade school to grad school*, OTA-SET-377. Washington, DC: U.S. Government Printing Office.
- Pasley, J. D. (1988, January). *APS Frontiers in Physiology Final Evaluation Report*. Chapel Hill, NC: Horizon Research, Inc.
- Pearson, W. Jr., & Fechter, A. (1994). *Who will do science? Educating the next generation*. Baltimore, MD: Johns Hopkins University Press.
- Tack, M.W., & Patitu, C. L. (1992). *Faculty job satisfaction: Women and minorities in peril*. ASHE-ERIC Higher Education Report No. 4. Washington, DC: The George Washington University, School of Education and Human Development.
- Tapia, R. (2001). Lack of Minority Leadership: Possible Causes and Plausible Solutions (Chapter 11). In: *Scientists and Engineers for the New Millennium: Renewing the Human Resource*. D.E. Chubin, W. Pearson Jr., Editors. Washington, DC: Commission on Professionals in Science and Technology.  
(<http://www.cpst.org/S&Es%20for%20the%20New%20Millennium.htm>)