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A Retrospective Look at 20 Years of ASM Education Programs (1990-2010) and a Prospective Look at the Next 20 Years (2011-2030)

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Professional societies provide visibility and legitimacy to the work of their post secondary educator members, advocate best practices in courses and sponsored student research, and establish deep networks and communities that catalyze members to collectively engage in undergraduate teaching and learning scholarship. Within the American Society for Microbiology (ASM), the Education Board, established in the mid-1970s, assumes this role. I have been fortunate enough to watch several pivotal programs support our growth and change the status quo by providing opportunities for biology educators to flourish. In this retrospective review, the background and details I offer about each initiative help explain ASM Education offerings, how our growth has been supported and how the status quo has changed. In this prospective look, I offer my vision of the future in post secondary education where classroom learning is student-centered and focused on global problems affecting our health and environment. For the profession to proliferate, the ASM must provide members as many opportunities in learning biology as they do with advancing biology to new frontiers.

The Education Board of the American Society for Microbiology (ASM) was established in the mid-1970s to address the graduate and medical education needs of ASM members. Since then, I have watched our offerings evolve from a small, graduate-level travel grant program for ASM meetings to a growing suite of professional development and networking opportunities including fellowships, publications, and conferences. Along the way, our audience has expanded from graduate students to undergraduate biology and K-12 teachers, students of all ages, researchers, and the public.

I have been fortunate enough to watch several pivotal programs and projects support our growth and change the status quo by providing opportunities for biology educators to flourish. These include the: (i) Coalition for Education in the Life Sciences, (ii) ASM Division on Microbiology Education, (iii) ASM Conference for Undergraduate Educators, (iv) ASM *Journal of Microbiology & Biology Education*, and (v) ASM Fellowship Fund. In this review, the background and details I offer on each initiative help explain ASM Education offerings, how our growth has been supported, and where we are headed.

Coalition for Education in the Life Sciences. More than 80 professional societies represent disciplines in the life sciences — genetics, microbiology, ecology, etc. — far more than those for their chemical, engineering, mathematical, physical, psychological, and social sciences counterparts. Such diversity may serve the research interests of scientists very well, but it also supports fragmentation. This fragmentation, in turn, results in a narrow focus that is particularly detrimental for biology education.

The Coalition for Education in the Life Sciences (1991-1998) was a national partnership of professional societies dedicated to improving undergraduate biology education (16, 17). Formation of the coalition brought about a paradigm shift for the societies; rather than compete with one another for students in the pipeline to become scientists, the organizations worked together to address critical issues in biology education. The coalition mobilized ASM and other societies in four important ways. First, it catalyzed society members to establish forums for discussions about teaching and pedagogy at disciplinary meetings. Second, it stressed the need for society members to publish papers and opinions on science education. Third, it encouraged the organizations to take steps to ensure that students entering the workforce were racially and ethnically diverse. Lastly, it challenged the societies to establish committees, allocate resources, and recruit staff expressly for administering and supporting educational programming. (In 1990, ASM was the only biological society with full time education staff members.)

ASM Division on Microbiology Education. The interests of ASM members comprise the full spectrum of microbiology; this fact is reflected by the Society's partition into 27 divisions which, in turn, reflect the primary research areas of ASM members (e.g., immunology, virology, or public health). Each division has representation on the ASM Council (the Society's governing board), which is responsible for ASM activities. In 1988, Robert Krasner, Providence College, RI, presented the ASM leadership with a proposal to form an

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education division (3). Krasner cited a study reporting that approximately 50% of doctoral students earn their initial training from small, primarily undergraduate colleges. He noted how these institutions could track their contribution to the workforce and use it as a basis to request encouragement and support from professional societies. He and other proponents of the new division envisioned it both as a home for existing members whose primary activity is teaching, and as a means to attract new ASM members. It took nearly five years, but Krasner's proposal for the ASM Division on Microbiology Education received full approval from the ASM Council in 1993. Today, the division is a forum for members interested in microbiology education, from K-12 to postdoctoral levels. Its 4,000 members form the backbone of ASM education programs and initiatives, such as the ASM Conference for Undergraduate Educators and the *Journal of Microbiology & Biology Education*. Establishment of the division guaranteed planned sessions about pedagogy at the ASM General Meeting. In addition, teaching challenges, the discussion of which was once taboo at life science professional society meetings, are now openly addressed, and educators can seek advice from colleagues about classroom problems, teaching innovations, and recruitment and retention challenges.

ASM Conference for Undergraduate Educators. Education sessions at the ASM General Meeting proliferated through the early 1990s from two sessions in 1988 to sixteen in 1993; however, ASM educator members wanted even more opportunities for in-depth discussions about the undergraduate curriculum. In 1993, these members called for revamping the undergraduate microbiology curriculum. A core group of approximately 100 microbiologists gathered for consensus-building discussions prior to the ASM General Meetings of 1994 to 1996. These discussions culminated in the first version of the ASM Recommended Curriculum Guidelines for Microbiology (14). This same core group advocated continued sponsorship of the gathering, envisioning it as a forum for educators to advance the guidelines by sharing their latest and best teaching strategies and innovations. Today, the gathering is held annually, in international esteem, as the ASM Conference for Undergraduate Educators (ASMCUE) (2). Attendance has tripled, and more than 300 biologists from around the world attend to improve their teaching techniques, engage in teaching as a scholarly endeavor, and identify with a community. Topics include teaching, learning and assessment, classroom and independent student research, student advising and mentoring, graduate training and professional skills development, K-12 outreach, and community service. Faculty present papers and posters; publishers and authors showcase textbooks and multimedia programs. Post-conference surveys suggest that 80% of the attendees indicate ASMCUE as their primary source for professional development.

The conference provides fertile ground for new initiatives. For example, MicrobeLibrary, a collection of peer-reviewed teaching resources was created by and for the biology community at ASMCUE (4). The community designed the library to have two unique features: all items (i) align with key microbial concepts and basic laboratory skills for undergraduate education, and (ii) are peer reviewed for scientific accuracy, educational quality, and visual presentation.

ASM *Journal of Microbiology & Biology Education*. I believe one of the most effective means that professional societies can use to elevate the scholarship of teaching in their disciplines is to establish a peer-reviewed research journal *in teaching and learning*. When biologists rigorously and systematically evaluate and reflect on their own teaching practices by seeking evidence that students are learning, then their students benefit. When biologists communicate their findings in publications, then their practices become visible and adoptable by the community. This adoption supports reform efforts in academic departments and subsequently sustains novel practices in the discipline. Ernest Boyer in *Scholarship Reconsidered* (11) states, "The work of the professor becomes consequential only as it is understood by others." He continues, "When defined as scholarship, however, teaching both educates and entices future scholars." ASM first formally recognized the scholarship of teaching in undergraduate biology in 2000, when Spencer Benson, University of Maryland, and Amy Vollmer, Swarthmore College, PA, launched the first issue of the Society's *Microbiology Education Journal* (5). Prior to the launch, ASM publications were limited to the scholarship of discovery through its journals or the scholarship of application through its laboratory manuals for clinical microbiology. By 2003, *Microbiology Education Journal* had driven the ASM faculty programs to new standards of teaching excellence. ASM faculty programs shifted from monitoring *faculty* gains in knowledge and skill to monitoring *student* gains in knowledge and skill *based upon faculty application of effective teaching and mentoring*. The focus on teaching shifted from effective teaching to scholarly teaching as measured by students' learning in biology. A new benchmark for success shifted from asking *how many faculty participated* in ASM programs to asking *how (and what type of) students were learning (or not) based on faculty who modified their teaching* having participated in ASM programs. As a result of these shifts, ASM made two changes. First, ASMCUE required assessment data to demonstrate student learning (or not) for all ASMCUE poster presentations beginning in 2004. Second, ASM launched in 2005 the Biology Scholars Program, a national leadership initiative for biologists to increase their knowledge and skills in classroom assessment, science education research and scholarly publishing about learning while ultimately promulgating the scholarship of teaching and learning in biology (6).

In 2008, *Microbiology Education Journal* became the *Journal of Microbiology & Biology Education* with a mission to promote good pedagogy and design, foster scholarly

teaching, and advance biology education research. In the past year, the Journal has experienced tremendous growth and overwhelming acceptance by the global community, having become openly accessible and internationally indexed (12). JMBE published 18 scholarly articles from a total of 56 submissions in 2010, compared to 12 scholarly articles from a total of 23 submissions in 2009.

ASM Fellowship Fund. The ASM Fellowship Fund supports students, young scientists, educators, and career microbiologists (7). Established in 1996, it supports individually-based training in research, teaching, and public policy. Among the programs supported by the fund are the ASM undergraduate research fellowships. These fellowships help undergraduate students remain in the laboratory during their summer breaks, diverting them from the need to work outside the microbiological sciences. In 2005, the staff conducted a longitudinal survey looking back at 20 years of programming. We learned that many of our former fellows connect their participation in an ASM fellowship to other professional milestones, such as the decision to pursue a doctoral degree, acceptance into graduate school, and being launched into a scientific career. They reported that their fellowships gave them opportunities to conduct independent research, write research proposals, make figures of data, write abstracts, and navigate large scientific meetings.

The Fellowship Fund has yielded deep partnerships for the Society. With the Centers for Disease Control and Prevention, ASM manages a postdoctoral fellowship in infectious diseases and public health that, in 15 years, has trained nearly 100 scientists (8). The ASM Watkins Graduate Fellowship Program supports graduate students from underrepresented minority groups to conduct three years of microbiology research. Each year, about 60% of our Watkins fellows' support is derived from partnering institutions. In 2000, ASM was selected to partner with the National Institutes of Health to manage the Annual Biomedical Research Conference for Minority Students, which encourages undergraduate minority students to pursue advanced training in biomedicine (9). The conference has grown from approximately 1,000 to more than 3,000 participants since its establishment. In 2000, President Clinton recognized the ASM for its commitment to diversity and the ASM fellowships (10). Establishing the fund has sent a strong message to the community about ASM's commitment to students and scientists-in-training.

The Future

The time is now; the catalyst is the Internet. More and more, higher education is transforming from closed, instructor-led classrooms to open, student-directed communities of learning. College-level content is accessible anywhere and anytime. Formal courses, such as those from MIT OpenCourseWare and the Open University (United Kingdom), are available to all of us. In addition, learning resources from collections such as the National Science Digital Library, Open Educational Resources, and the Public Knowledge Project, bring up-to-date information to the public. Wikipedia, YouTube, and Flickr convert and organize content into accessible formats for students from diverse learning, linguistic, and cultural backgrounds. New communities in Facebook, LinkedIn, and WordPress also facilitate sharing and discussions. Smart phones and other mobile devices make content and people accessible to students continuously. I believe these platforms (and others in the future) will continue to transform the lives of college students and faculty involved in the science curriculum. Anyone wanting to discover new content and attempt new experiences will be able to do so using emerging technologies, and by accessing information and experts from the Internet.

College Students. College students are among the most savvy and efficient consumers of new content and, in the future, I envision them controlling their own learning. Students will seek new content as they gain deeper understanding and perform new tasks as they develop skills. Learning will be augmented through new technologies to create and simulate the real world. The only deciding factor for students seeking to acquire new content and develop skills is their own motivation to persevere.

No longer will scientists be invisible to students. The websites of faculty and university research teams, as well as sponsors of such research, will proliferate on the Internet, and such exposure will give students access to scientists, research teams, laboratories, and collaborators from around the world. Students will be able to form expansive networks of peers, experts, and mentors to augment their understanding, develop research projects, and practice skills. They will not only call upon assigned advisers but also reach out to multiple mentors in their network for knowledge and guidance. With the Internet and services such as Skype that enhance communications and foster collaborations, mentors will not be limited by geographical or temporal boundaries.

College students will become more efficient learners due to instruments such as VARK and Honey and Mumford that help identify their unique learning styles or preferences (e.g., how they obtain or give up information) (15, 19). Once students are cognizant of their preferences, they can select from a variety of learning modalities to accommodate their own style. They are able to select their own approaches for optimal learning such as readings and discussions (blogs); audio recordings or visual presentations (PowerPoint or YouTube); problems sets and simulations; and field studies and team projects.

College students will look to higher education for broader and more balanced training than strict subject matter content. The workplace will become even more competitive; prospective employees will need to be critical and analytical thinkers, better communicators, and collegial team players in a global society. Thus, students will seek new skills. For future scientists, these skills will need

to encompass the personal (e.g., financial, educational, and career planning) to the professional (e.g., presentations, grants procurement, publishing, teaching and mentoring, career transitioning, and ethics).

Faculty. Faculty members will be masters of engagement. Their previous role of presenting a series of unconnected facts about biology will be replaced by one challenging students with real world, global problems and guiding them in learning. No longer will educators need to present foundational knowledge because relevant content — from course syllabi to instructor handouts to e-textbooks and entire courses — will be on the Internet. Faculty time will be spent guiding students through problem sets and leading group discussions, debates, and discourse in both on-site and virtual communities. Faculty will become effective guides of content, mentors to students about science and careers, curriculum developers, and scholars in teaching and learning. According to The Horizon Report 2010 (18) from the New Media Consortium, open content – a trend that began in 2001-2002 with the MIT Open Courseware Initiative – will reach mainstream use in the next 12 months. The availability of open content is particularly important in areas of the world where the cost of education is prohibitive or access to education is inconvenient or not available.

College faculties will be skilled at identifying prior understanding among students and tailoring instruction to incorporate student interests, learning goals, and preferred modalities of learning. They will become "learning scholars," continuously and rigorously monitoring student acquisition of subjects, and responding immediately and effectively to their learning needs. Gaps in understanding or challenges to mastering information will be disclosed immediately using clickers and mobile devices, for example, which make assessing student understanding a dynamic process. Teaching will be dependent upon continuous evidence that student understanding deepens, and it will be tailored for individual students in the context of their interests, learning preferences, and goals. Successful faculty members will continuously modify their instruction to meet student needs and successfully guide students to greater understanding of their personal interests.

College faculties will be skilled at advising and leading discussion groups, shepherding students to deeper understanding about biology. They will genuinely support all students to (i) master a foundational knowledge about the natural world, (ii) solve real-world problems on a global scale, and (iii) pursue their own interests and select the best career option among the diversity of opportunities in biology. Successful faculty will guide students to become scientifically literate about the microbial world and its influence on the global world.

Science Curricula. College science curricula will be driven by solving real problems locally, across regions, and spanning countries and continents. Content will no longer be delivered in small chunks of unrelated, unconnected, and irrelevant material. Learning will be driven by seeking solutions to challenges that threaten our health, education, livelihood, and national security (1, 13). Instruction will break apart the big challenges and focus on small scale, but interconnected and interesting, questions to study.

Course content and instruction will be built around smaller groups of subject matter experts, experts-in-training, and novices collectively and collaboratively sharing ideas, researching topics, gaining knowledge, identifying solutions, drawing consensuses, and developing solutions to unique problems. What will sustain them as a learning community is a common goal to solve the same problem.

A Vision of the Future. For such a future to happen, the role of professional societies must be to foster a dynamic community of practice. In the microbiology sector, the community must be driven by a vision for the future where all members adhere to the highest standards of teaching and mentoring just as they do to scientific inquiry; actively encourage the entrance and success of all students in microbiology; mentor students and advise the public about microbiology for the common good; and embrace the scholarship of teaching. What role will ASM play in this future? Specific milestones I'd like to see in the next 20 years include:

- ASM journals, conferences, colloquia, and public policies advance scholarly teaching in microbiology and excellence in science education as vigorously as they advance scholarly research in microbiology and excellence in science discovery
- The American Academy for Microbiology recognizes and rewards the scholarship of teaching and learning as it does the scholarship of discovery through nominations, awards and colloquia
- All members are informed about the diversity of careers — from entry-level positions requiring no degrees to highly technical positions requiring post-graduate training — and use this knowledge to guide students at every level of development
- All members in colleges, universities, and professional schools assume responsibility for ensuring that all students, particularly first- and second-year undergraduate students in all disciplines, understand the nature of science and appreciate the significance of the microbial world
- All members model for the public a respect for the natural world, recognizing both the beneficial and destructive roles of microorganisms

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