In July, 300 microbial scientists from undergraduate institutions, community colleges, and doctoral universities met to celebrate the 25th anniversary of the ASM Conference for Undergraduate Educators (ASMCUE) to share methods for teaching and mentoring undergraduate students in the microbial sciences. ASM Carski Award Winner Mark O. Martin from the University of Puget Sound opened the conference, proudly describing ASMCUE as his quorum—a community of people dedicated to training undergraduate students.

The aim in modern education is to train the individual for usefulness. With the present crowded curricula in schools and colleges it is essential that the material presented for the training of students be selected with the greatest care.

The key here is usefulness. How can we teach so that it’s helpful, valuable, and informative to students? What are the new teaching paradigms for the 21st century? University of Maryland and University of Macau Professor Spencer Benson’s closing talk, “25 Years of ASMCUE and STEM Education: Past, Present, and Future,” addressed these questions.

Teacher Centered to Learner Centered
Over the past decade, campuses have gone from being centered upon clusters of buildings and libraries to having extensive wireless connectivity and fewer buildings. This changes the teaching paradigm for scientists worldwide. No longer are scientists the sole custodians of learning and libraries the sole repositories of information.

The post-millennials, 68 million people born between mid-1990 and mid-2000, have grown up with the Internet and computers, and their expectations for higher education learning are vastly different from those of their teachers, whose training environment included large lecture-style classes, cookbook labs, and hours in the library. Today, all students are digital learners who use various devices—smartphones, tablets, computers, and TVs—to communicate and learn new information. They access information in all forms—animations, videos, podcasts, texts, graphics, interactive games, and emerging augmented and virtual realities. How many educators today adapt their instruction with these new learners in mind? How many institutions go further by hosting virtual classes and office hours, making all course materials public and showcasing student work in electronic portfolios? Students are empowered through digital communications to learn more on their own than through traditional lecture-based pedagogies. They can take control of their learning and become more self-reliant, accountable, and confident.

Information Dissemination to Knowledge Building
In the traditional classroom, information flowed from teacher to students with minimal opportunity for discussion. Teachers broadcasted information
through lectures augmented with a syllabus and handouts. Discussions were limited to recitations or separate laboratory periods. The “sage on stage” concept sums up the learning environment before the Internet.

Now, knowledge building is an approach formed around real-world problems of significance to students, providing the “usefulness” from Bergey’s passage. In science, knowledge building happens through classroom-based undergraduate research experiences (CUREs). Many microbiology CUREs challenge students to identify, characterize, and publish information about an unknown bacteriophage from soil or water. CUREs can vary widely in design and implementation, but students do the work of scientists in areas for which solutions or answers are not yet known. They pose questions, design studies, collect and analyze data, share findings, and build on newly acquired knowledge. CURE educators introduce rigorous methodology, provide meaningful conclusions, and foster deeper understanding about the process of science. A critical difference separating traditional microbiology labs and CUREs is the lack of known answers or solutions to problems. The laboratory experience has transitioned from a staged and controlled environment to one characterized by uncertainty, challenges, and continuously evolution.

**Acceptance to Accountability**

Student assessments, concept inventories, program evaluations, evidenced-based teaching, the scholarship of teaching and learning, and discipline-based education research are terms that collectively show the shift in higher education from acceptance to accountability. In the mid-20th century, a demand for educational opportunities for all required rapid expansion in higher education with scant oversight about the instruction’s quality.

The Commission on the Future of Higher Education was established in 2005 to reform education in college and universities and focused on four areas: access, affordability, accountability, and quality instruction. ASM members called for more professional development and resources to advance quality instruction, accountability, and access.

At the time, ASM offered and continues to sponsor the ASM Recommended Core Curriculum and Laboratory Skills, ASMCUE, and the *Journal of Microbiology & Biology Education* to promote quality instruction in the microbial sciences. ASM also offers two programs, the ASM fellowships and Annual Biomedical Research Conference, for Minority Students (ABRCMS) to increase access to science. ASM created a program in 2000 for faculty to develop methods to demonstrate understanding around core microbial concepts and competencies for microbiological skills. Assessments to measure cognitive understanding, microbiological skills, scientific thinking, interest and motivation, and retention in science continue to serve the community. Faculty at all colleges and universities are held accountable for their effectiveness as instructors, mentors, researchers, and scientists.

Benson closed with a quote from the notable scholar and educator John Dewey, who stated in 1919, “If we teach today as we taught yesterday, then we rob our children of tomorrow.” ASMCUE is dedicated to the undergraduate microbial science education for tomorrow.