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| Perspective

Updated ASM Curriculum Guidelines describe core microbiology content to modernize the framework for microbiology education

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ABSTRACT Curricular guidelines promote standardized approaches to coverage of essential knowledge and skills in undergraduate education. The American Society for Microbiology (ASM) Curriculum Guidelines for Undergraduate Microbiology were developed in 2012. Continuous, rapid growth of knowledge in science and a dynamic, changing world necessitate updates to these guidelines. As such, ASM formed a task force in the summer of 2022. The task force assessed the 2012 ASM Curriculum Guidelines considering advancements in technology, an understanding of an expanded role of microbes, and a broader scope addressing relevant social and environmental aspects of microbiology. Language in the updated guidelines was also modified to better include eukaryotic microbes, viruses, and other acellular microbes. The task force formed working groups, each aimed at revising specific sections of the 2012 ASM Curriculum Guidelines. The revisions to the ASM Curriculum Guidelines were reviewed by subject matter experts and education stakeholders. Feedback from this peer review was incorporated into the updated guidelines, and further comments were solicited from the ASM Conference of Undergraduate Educators (ASMCUE) attendees in November 2023 before these guidelines were finalized. In this article, we describe the rationale and development of updated ASM Curriculum Guidelines which identify foundational concepts that will serve to improve microbial literacy and that can be expanded upon to address more advanced and specialized topics.

KEYWORDS microbiology education, curriculum, learning objectives

CORE MICROBIOLOGY CONCEPTS ARE THE FOUNDATION OF MICROBIAL LITERACY

Microorganisms play essential roles in most aspects of the human experience including technology, industry, healthcare, research, and ecology. The general public views microbes as dangerous invaders, however, as emerging infectious diseases, food recalls, and beach closures dominate the headlines. Because most microbes are unseen, their essential and often beneficial roles are underappreciated at best and largely unknown. Teaching about the diverse and often beneficial roles played by bacteria, viruses, fungi, and other microbes in different habitats remains a priority for microbiologists worldwide (1).

The COVID-19 pandemic revealed many deficiencies in the public's microbiology literacy. Debates between scientific experts and untrained public influencers over disease transmission, the use of facemasks, and the utility of vaccines have had deadly consequences. Misinformation about core microbiology concepts spreads rapidly in communities lacking critical science literacy (2). Moving forward, healthcare professionals, epidemiologists, and microbiologists are spending significant time and resources on outreach programs, K-12 education, and undergraduate education initiatives. One

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crucial element of this work is to develop foundational concepts that define what it means to have microbiology literacy (1). This involves the core principles of biological sciences as laid out by Vision and Change (3) and alignment with the American Society for Microbiology (ASM) 2024 strategic framework (4).

Beyond improving their core microbiological knowledge and scientific literacy, it is also critical for students to develop empathetic communication skills (5) that enable them to effectively communicate with a non-scientific audience. This can enable students to advocate for the microbiological sciences and, in turn, improve the scientific literacy of the general public, which is increasingly important as the public forms opinions and makes critical decisions on topics like climate change, biotechnology, and public health measures.

In a call to action, the Journal of Microbiology and Biology Education (JMBE) created a themed issue around the topic of science literacy and collated a wide array of techniques that the scientific community is using to promote scientific literacy in the context of microbiology both inside and outside of the classroom (6). Approaches included having students engage with current events in interactive, multiweek activities that increase student motivation and agency (7) and assignments designed to help students assess scientific claims and fight misinformation (8). Providing opportunities for students to practice argumentation and develop their ability to communicate in a culturally sensitive manner would effectively promote their engagement with and connection to all members of the community, regardless of their previous experiences with science and potential exposure to scientific misinformation (5, 9).

Science is at the heart of scientific literacy, and knowing basic science is a fundamental first step. In 2011, American Association for the Advancement of Science (AAAS) and National Science Foundation (NSF) published guidelines for core concepts for teaching in the biological sciences. These guidelines, called "Vision and Change in Undergraduate Biology Education: A Call to Action" describe five core concepts that instructors should emphasize and that students should understand and be able to apply rather than simply memorize (3). These core concepts were: evolution, the relationship between structure and function, information flow, metabolic pathways, and biological systems. In addition to the five identifying these key concepts for students to develop mastery of, Vision and Change emphasizes skills, such as the ability to use scientific methods, mathematical reasoning, modeling, collaboration, and communication. The establishment of core conceptual knowledge that students should acquire enables educators to focus their teaching efforts and provides a consistent framework for all courses in the biological sciences. Microbiology is a complex, interdisciplinary science with deep connections to many different aspects of biology, such as genetics, evolutionary biology, biochemistry, and ecology.

In response to the call to action suggested by Vision and Change, the American Society for Microbiology (ASM) formed a task force in 2012 that used Vision and Change to shape the undergraduate microbiology curriculum, defining the core content for both general microbiology courses and microbiology curricula. Educators then used these fundamental statements to build learning objectives to use as a framework during course design (2, 10).

The updated guidelines continue to be rooted in Vision and Change and are well-aligned with the strategic plan described by ASM in a 2024 article (https://asm.org/about-asm/charting-asm-s-new-strategic-course; 4). This strategic plan includes establishing three scientific units: ASM Mechanism Discovery, ASM Applied and Environmental Microbiology, and ASM Health. There are also three strategic framework goals, focused on connecting stakeholders worldwide, emphasizing the societal impact of the microbial sciences, and shaping the future of microbial sciences, which are reflected in the updated guidelines. Microbiologists and other stakeholders from around the world were invited to contribute and provide feedback at several points during the development process. The updated fundamental and core skill statements were expanded to include statements emphasizing the impact of microbes on society. Finally, the updated fundamental statements will guide faculty as they teach the next generation of microbiologists impacting both current knowledge and future discoveries in the microbial sciences.

ADVANCES IN THE BIOLOGICAL SCIENCES REQUIRE CHANGES TO CURRICULAR GUIDELINES

The first set of ASM Curriculum Guidelines for Undergraduate Microbiology were published in 2012 (2). Since then, the role of microbiology in society has also shifted dramatically (11), with discoveries about the role of the human microbiome in human health and disease (12), advances in biological technologies such as CRISPR/Cas (13) and mRNA vaccines (14), the emergence of SARS-CoV-2 and the resulting COVID-19 pandemic (15), and the rise of scientific misinformation (16). New technologies used in microbiology, such as metagenomics, machine learning, and cultivation-independent analysis of microbial communities (17) have changed the skills needed by today's graduates (18). In higher education institutions, the course-based research experiences to promote equitable access to research experiences (19) and the expansion of discovery-driven (20) laboratory experiences reflect an increased emphasis on social and collaborative skills needed for effective communication in scientific disciplines. Courses are also being updated or redesigned to reflect principles of equity, diversity, and inclusion (21).

In response to both scientific advances that impact how research is done and societal changes that impact how science is taught, several other scientific communities have either established or revised their guidelines since 2012. The Genetics Society of America built a framework describing the core competencies and example student learning outcomes for an introductory genetics course (22). These are a combination of core questions about genetics and measurable skills students would need to fully answer each question. Similarly, a task force of the American Society of Cell Biology educators and CourseSource established a set of learning goals and objectives for their discipline. The Cell Biology framework was intended to describe the competencies and skills of all students in the biological sciences that they need to achieve before they complete their undergraduate degrees (23). The American Society for Virology (ASV) developed curriculum guidelines based on Vision and Change, describing the core content for students taking a stand-alone virology course (24). They also included recommendations for graduate virology coursework and the virology section of an introductory general microbiology course. A follow-up ASV project developed learning objectives designed to support virology education (24). The updated 2024 ASM Curriculum Guidelines for Undergraduate Microbiology provide specific guidance needed to apply the Vision and Change core recommendations to teaching microbiology in today's context.

THE REVISION TASK FORCE USED AN ITERATIVE PROCESS TO REVIEW AND UPDATE THE ASM CURRICULUM GUIDELINES

During the summer of 2022, ASM sent out an invitation for members to join a task force to update the ASM Curriculum Guidelines. The ASM Curriculum Guidelines Revision Task Force was composed of faculty from a variety of higher education institutions, demographics, and geographies. The initial step of analyzing the existing curriculum guidelines from 2012 was done by dividing into working groups to identify needed changes and revisions. The task force groups met regularly and worked on identifying areas that needed improvement. During the Spring of 2023, the task force groups began revising and rewriting the fundamental statements, ensuring that the wording was intentional in each case. After a series of discussions, debates, revisions, and reworking of the statements, the revised curriculum guidelines were sent to subject matter experts (SME) for feedback and suggestions. The task force received feedback and incorporated several changes into the guidelines based on helpful suggestions from the community of SME, ASM members focused on education and other stakeholders. Finally, the updated ASM Curriculum Guidelines were presented at the ASM Conference of Undergraduate

Educators (ASMCUE) in November 2023. We collected feedback from the general ASM community and ASMCUE audience. The ASM Curriculum Guidelines were finalized and then released to the ASM community on March 5, 2024.

NATURE OF UPDATES TO FUNDAMENTAL STATEMENTS AND SKILLS

The ASM Curriculum Guidelines task force expanded the range of the concepts related to microbiology, focused on generalizable statements over specific examples, and included more concepts from evolutionary biology. While updating the ASM Curriculum Guidelines, the task force combined similar fundamental statements and added fundamental statements to reflect the changing field of microbiology (Table 1). When updating the fundamental statements, the task force also expanded the focus of these statements to include eukaryotic microbes, viruses, and other acellular agents and adopted the use of the term microbe, as a more inclusive term with less focus on bacteria. Recognizing these statements are designed as declarative statements of foundational concepts in microbiology, we removed most of the examples given in the 2012 version of fundamental statements in favor of more generalized terminology. Throughout the revision process, the task force took an evolutionary biology approach, emphasizing microbial adaptations in the context of community ecology and selective pressures.

Along with changes to the core content, we updated and expanded the ASM Curriculum Guidelines regarding the skills needed by today's microbiology students to include those that are critical for all students to develop and practice in a typical microbiology laboratory course. These skills include lab safety, data analysis, the use of evidence to draw conclusions, and computational skills. We also combined and updated different methods to emphasize different approaches to microbiology, particularly bioinformatics, serology, and molecular methods. The updated core skills also include more detail on the role of microbiology in society, policy development, scientific ethics, and recognition of diverse scientists. Finally, we clarified and expanded our definition of scientific literacy skills such as the evaluation of credible sources and the communication of microbiology concepts to a variety of audiences. The entire process is diagrammed in Fig. 1.

ADVANTAGES OF USING CURRICULAR GUIDELINES

As with the original 2012 ASM Curriculum Guidelines, the updated fundamental statements are not a list of facts for students to memorize but instead serve to describe core principles of microbiology that students should understand and be able to apply in different contexts. Recently, a meta-analysis demonstrated that courses and curricula organized around measurable learning objectives lead to improved student performance, engagement, and retention of course content (25). A single fundamental statement could be the basis for several different learning objectives that address the ability of students to demonstrate both higher-order and lower-order thinking skills.

The development and use of concept inventories have revealed that our students continue to exhibit several misconceptions in the areas of microbiology (26, 27), such as the mechanism by which microbes acquire antibiotic resistance, how vaccines work, and the steps involved in DNA replication and transcription. Although it is likely that many of these misconceptions are brought into our microbiology classrooms from previous biology courses, by leveraging concept inventories and assessments that are tied to curricular guidelines, we can identify and even anticipate them. Educators can then tailor our learning activities and classroom activities/interventions to address these misunderstandings and prevent the persistence of misconceptions as students move through their majors.

The updated ASM Curriculum Guidelines provide a framework for faculty to scaffold their lessons both within courses, across courses, and between institutions teaching similar courses in the microbiological sciences. The updated fundamental statements are written based on priorities described by experts in the microbiological sciences as well

TABLE 1 Summary of changes made between 2012 ASM Curriculum Guidelines and the 2024 ASM Curriculum Guidelines[a]

Old FS #	Old fundamental statement	New FS #	New fundamental statement	Summary of changes made
Content Area: Evolution				
1	Cells, organelles (e.g., mitochondria and chloroplasts) and all major metabolic pathways evolved from early prokaryotic cells.	1	All cells, eukaryotic organelles (e.g., mitochondria and chloroplasts), and major metabolic pathways evolved from early progenitor cells.	Removed "prokaryotic" and rephrased to indicate *all* cells evolved from earlier cells.
2	Mutations and horizontal gene transfer, with the immense variety of microenvironments, have selected a huge diversity of microorganisms.	2	The diversity of microbes has arisen because of processes that include horizontal gene transfer, mutation, reassortment, recombination, recombination, and natural selection in varying ecological niches favor the growth and survival of certain variants.	More detail about the mechanisms of evolution that have led to microbial diversity.
3	Human impact on the environment influences the evolution of microorganisms (e.g., emerging diseases and the selection of antibiotic resistance).	3	The evolution of microbes is impacted by their interactions with the environment and a variety of ecological forces, including other microbes, humans, and habitats.	More emphasis is placed on the interaction between microbes and their environment, including those not associated with humans.
4	The traditional concept of species is not readily applicable to microbes due to asexual reproduction and the frequent occurrence of horizontal gene transfer.	4	Phylogenetic trees best reflect the evolutionary relatedness of all organisms, although microbial lineages may be difficult to define due to horizontal gene transfer or lack of conserved genes.	Elements of old FS 4 & 5 (difficulty in naming species and utility of phylogenetic trees for classification of bacteria) were combined into new FS 4.
5	The evolutionary relatedness of organisms is best reflected in phylogenetic trees.			This FS has been combined with four as described above.
Content Area: Cell Structure & Function				
6	The structure and function of microorganisms have been revealed by the use of microscopy (including bright field, phase contrast, fluorescent, and electron).	5	The structure and function of microbes are revealed by the use of microscopy, culture, and metabolic analyses, molecular methods, and bioinformatic tools.	Expanded statement to include non-microscopy-based methods used to study microbial structure and function.
7	Bacteria have unique cell structures that can be targets for antibiotics, immunity, and phage infection.	6	The distinct structures and processes in microbes can be targets for interspecies competition, antimicrobial treatments, and host immunity.	Focus shifted from bacteria to all microbes.
8	Bacteria and Archaea have specialized structures (e.g., flagella, endospores, and pili) that often confer critical capabilities.	7	Microbes have evolved structures adapted for specific functions that are often associated with a fitness advantage in a particular environment.	Directly linking microbial structures with their functions and fitness.
9	While microscopic eukaryotes (for example, fungi, protozoa, and algae) carry out some of the same processes as bacteria, many of the cellular properties are fundamentally different.	8	Microbes have unique genomes, structures, and/or biochemical characteristics that distinguish them from each other.	Added detail about the cellular properties that differ between the different microbial categories.
10	The replication cycles of viruses (lytic and lysogenic) differ among viruses and are determined by their unique structures and genomes.	9	The replication of viruses is determined by their unique structures, DNA or RNA genomes, and the cells they infect.	Expanded the detail of viral replication.
	No previously existing statement	10	Microbial reproductive cycles consist of sequential processes.	Added to emphasize similarities for all microbes.
	No previously existing statement	11	Obligate intracellular microbes require living host cells for replication.	Added to focus on similarities obligate intracellular microbes.
Content Area: Metabolic Pathways				
11	Bacteria and Archaea exhibit extensive, and often unique, metabolic diversity (e.g., nitrogen fixation, methane production, anoxygenic photosynthesis).	12	Bacteria and Archaea exhibit extensive metabolic diversity, including nitrogen fixation, methane production, and anoxygenic photosynthesis, many of which are unique to these two domains.	Edits to remove parenthetical statements.

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TABLE 1 Summary of changes made between 2012 ASM Curriculum Guidelines and the 2024 ASM Curriculum Guidelines[a] (*Continued*)

Old FS #	Old fundamental statement	New FS #	New fundamental statement	Summary of changes made
12	The interactions of microorganisms among themselves and with their environment are determined by their metabolic abilities (e.g., quorum sensing, oxygen consumption, nitrogen transformations).	13	Intrinsic factors, such as genotype, metabolism, and cell structures, impact the survival and growth of microbes.	Restructured old FS 12 and FS 13 to separate metabolism and other intrinsic factors (new FS 13) from the environmental extrinsic factors (new FS 14).
13	The survival and growth of any microorganism in a given environment depends on its metabolic characteristics.			Integrated into new FS 13.
14	The growth of microorganisms can be controlled by physical, chemical, mechanical, or biological means.	14	Extrinsic factors, such as abiotic and biotic interactions in the environment, can impact survival and growth of microbes.	Changed emphasis to both growth and survival of microbes, rather than simply human-centric control of microbial growth.
	No previously existing statement	15	Most microbial life is currently unculturable and therefore both cultivation-dependent and cultivation-independent techniques are used to identify microbial populations and their potential metabolic pathways.	Added statement to note that we cannot culture most microbes in the lab and there are rapidly developing and innovative techniques that are culture-independent.
Content Area: Information Flow and Genetics				
15	Genetic variations can impact microbial functions (e.g., in biofilm formation, pathogenicity, and drug resistance).	16	Genetic variation can influence microbial structures and their functions.	Edits to remove parenthetical statements and added mention of structures.
16	Although the central dogma is universal in all cells, the processes of replication, transcription, and translation differ in Bacteria, Archaea, and Eukaryotes.	17	Although the flow of information from DNA to RNA to protein is universal in all cells, aspects of the processes of replication, transcription, and translation differ between Bacteria, Archaea, and Eukarya.	Edits to remove jargon (Central Dogma).
17	The regulation of gene expression is influenced by external and internal molecular cues and/or signals.	18	The regulation of gene expression is influenced by external and internal molecular cues and signals.	Removed and/or from the fundamental statement.
18	The synthesis of viral genetic material and proteins is dependent on host cells.	19	Non-cellular infectious agents, such as viruses, prions, viroids, and satellites, are dependent on host cell processes in order to replicate.	Changed to include acellular microbes that are not viruses.
19	Cell genomes can be manipulated to alter cell function.			Rephrased and combined with the new FS 26.
Content Area: Microbial Ecology				Changed the name from Microbial Systems.
20	Microorganisms are ubiquitous and live in diverse and dynamic ecosystems.	20	Microbes are ubiquitous, found in diverse and dynamic ecosystems, where they use available resources and often form complex communities.	Added details about how microbes live in diverse habitats in complex communities using available resources.
21	Most bacteria in nature live in biofilm communities.			Deleted statement - info added to statement #20.
22	Microorganisms and their environment interact with and modify each other.	21	Microbes and the environment interact with and affect each other.	Modified to state the environment rather than their environment.
23	Microorganisms, cellular and viral, can interact with both human and nonhuman hosts in beneficial, neutral, or detrimental ways.	22	Most microbes interact with hosts in beneficial or neutral ways, with a minority having a detrimental impact on their host.	Statement changed to reinforce the concept that a minority of microbes are pathogens.
	No previously existing statement	23	The health of the environment and all organisms (microbes, plants, humans, other animals) are closely linked and interdependent, as described by the One Health paradigm.	Given the interdisciplinary nature of microbiology, we added the One Health Framework to reinforce the concept of the interconnectedness of all life on our planet.
Content Area: Impact of Microbes				

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TABLE 1 Summary of changes made between 2012 ASM Curriculum Guidelines and the 2024 ASM Curriculum Guidelines[a] (*Continued*)

Old FS #	Old fundamental statement	New FS #	New fundamental statement	Summary of changes made
24	Microbes are essential for life as we know it and the processes that support life (e.g., in biogeochemical cycles and plant and/or animal microbiota).	24	Microbes and their communities are essential for supporting all life as we know it.	Edited to remove parenthetical, changed microorganisms to microbes and included their communities.
25	Microorganisms provide essential models that give us fundamental knowledge about life processes.	25	Microbes are used as models that provide fundamental knowledge about life processes.	Changed the word microorganism to microbe to include non-cellular agents.
26	Humans utilize and harness microorganisms and their products.	26	Humans leverage microbes and their products to address problems and improve quality of life.	Rephrased to suggest why microbes and their products are used by humans.
27	Because the true diversity of microbial life is largely unknown, its effects and potential benefits have not been fully explored.	27	The extent of microbial diversity is largely unknown, and exploration of this diversity is critical to understanding microbes and their role in the biosphere.	Edited to emphasize the critical need to study microbial diversity and their roles.
	No previously existing statement	28	A minority of microbes are pathogens that can cause diseases and harm host organisms, society, and ecosystems.	Added to emphasize that most microbes are not pathogens and to expand on how pathogens cause harm.
	No previously existing statement	29	The extent of microbial damage can be minimized by host-derived and external factors, including the microbiome, antibiotics, and immunity.	Added to reflect the nature of immunity, the role of internal and external as well as environmental factors in responding to microbial damage. The microbiome was not mentioned in the previous guidelines.
Content Area: Scientific Thinking & Microbiology Lab Skills				The Scientific Thinking and Microbiology Laboratory Skills were combined and reordered.
28a, 28b, 38	Demonstrate an ability to formulate hypotheses and design experiments based on the scientific method. Analyze and interpret results from a variety of microbiological methods and apply these methods to analogous situations.	1	Apply scientific methods: a. Investigate microbial systems. b. Formulate hypotheses and design well-controlled experiments. c. Analyze, troubleshoot, and interpret results from a variety of methods. Draw evidence-based conclusions. d. Document and communicate the methods, results, and conclusions. e. Collaborate, give and receive feedback, update methods, and reassess conclusions.	Combined statements 28 a and b and refocused on the study of microbial systems. Added the need to troubleshoot and use a variety of methods in addition to microbiological. Added emphasis on the use of evidence to draw conclusions. Added emphasis on documentation and record keeping as well as collaboration, and iterative nature of the scientific method.
29a	Use mathematical reasoning and graphing skills to solve problems in microbiology.	1f	Use quantitative reasoning and computational skills, such as mathematical reasoning, graphing, and statistics to evaluate and interpret data in microbiology.	Expanded to reflect the increasing reliance on computational and quantitative reasoning in microbiology. We also added the need to evaluate and interpret data rather than problem-solving.
32	Properly prepare and view specimens for examination using microscopy (bright field and, if possible, phase contrast).	2	Properly prepare, view, and analyze specimens using microscopy.	Removed mention of bright field and phase contrast and added analysis.
33	Use pure culture and selective techniques to enrich and isolate microorganisms.		Removed as standalone statement.	This is combined with new statement 3.
34	Use appropriate methods to identify microorganisms (media-based, molecular and serological).	3	Apply appropriate microbiological, molecular, serological, and bioinformatics methods to isolate and differentiate microorganisms.	Expanded the types of approaches taken to identify microbes and included bioinformatic methods which are increasingly used today.
35	Estimate the number of microorganisms in a sample (using, for example, direct count, viable plate count, and spectrophotometric methods).	4	Estimate the number of microorganisms in a sample by direct or indirect means.	Modified to make it clearer.

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TABLE 1 Summary of changes made between 2012 ASM Curriculum Guidelines and the 2024 ASM Curriculum Guidelines[a] (*Continued*)

Old FS #	Old fundamental statement	New FS #	New fundamental statement	Summary of changes made
36	Use appropriate microbiological and molecular lab equipment and methods.		Removed as standalone statement.	This is combined with new statement 3.
37	Practice safe microbiology, using appropriate protective and emergency procedures.	5	Practice microbiology in a responsible and safe manner, using appropriate safety equipment and adhering to emergency procedures and guidelines.	Emphasizing the need to take responsibility for lab safety and adherence to the guidelines.
30a	Effectively communicate fundamental concepts of microbiology in written and oral format.	6	Effectively communicate fundamental concepts of microbiology with consideration of scientific and non-scientific audiences.	Added critical consideration of the need to tailor the communication strategy to the audience.
30b	Identify credible scientific sources and interpret and evaluate the information therein.	7	Identify, interpret, and evaluate credible sources of information and cite them appropriately.	Revised to describe the steps involved and includes the importance of citation in evaluating sources.
31a	Identify and discuss ethical issues in microbiology.	8	Describe the intersection between science and society, such as emerging technologies, policy development, the importance of ethics in the scientific process, and recognize the historical and ongoing contributions of diverse scientists.	This has been expanded to relay the interdependence of microbial science and an ethical and diverse society with examples that directly relate to issues of equity, and diversity in the sciences.

[a]The original fundamental statements were revised, and new fundamental statements were created to reflect current priorities in microbiology undergraduate education.

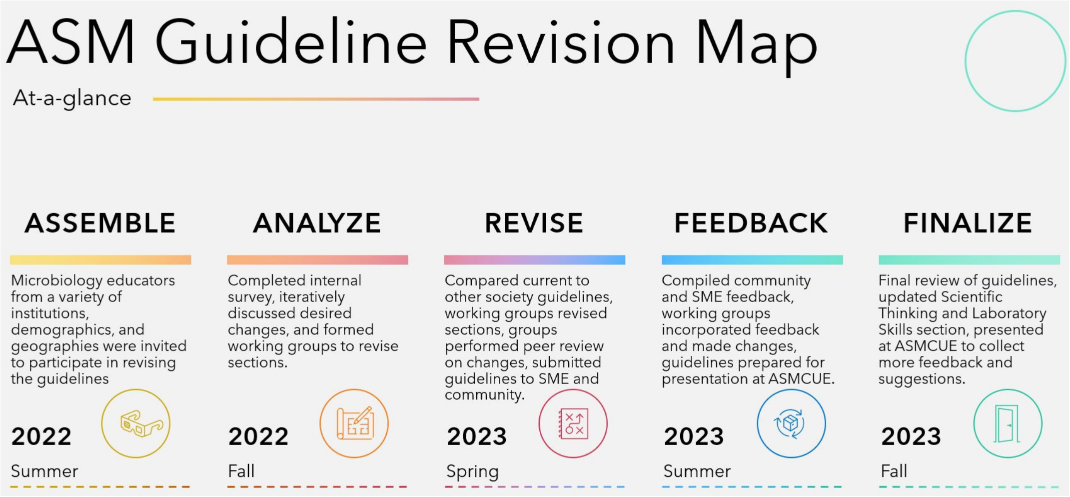

FIG 1 Process used to revise the ASM Curriculum Guidelines. We assembled a group of microbiology educators to analyze and then revise the 2012 guidelines. The draft revisions were reviewed by subject matter experts (SME), educators, and attendees of the 2023 ASM Conference of Undergraduate Educators (ASMCUE). The task force incorporated feedback to produce the updated ASM Curriculum Guidelines.

as the NSF and AAAS in Vision and Change (8, 10). These statements are designed to be used as general guidelines that are flexible for individual educators or institutions to implement at multiple levels. The updated guidelines will help faculty revise individual courses as they build learning objectives, assessments, and activities for microbiology courses and laboratories (28, 29). More universities are exploring variations in online and hybrid learning and instructors are changing how they present content to accommodate learning in these formats. The updated guidelines are adaptable and can be used across many different teaching modalities. Academic programs offering a degree, minor, or certificate in microbiology can use these guidelines to prioritize and organize coursework designed to teach microbiology students. Schools that offer multiple microbiology courses can organize a curriculum that introduces the core topics in early courses, allows students to practice with these topics in mid-level courses, and finally achieve mastery of the concepts described in the fundamental statements in advanced courses (30–32). The updated ASM Curriculum Guidelines allow faculty to focus on core concepts rather than being buried in a breadth of content and the expense of more contextualized learning.

The updated ASM Curriculum Guidelines also provide a framework to establish learning goals and intended student learning outcomes in the initial steps of Backward Design (28). The fundamental statements are generalized concepts that can be used to create specific higher-order and lower-order learning objectives. These learning objectives then serve as a basis for formative and summative assessments and learning activities designed to help students achieve these focused intended student learning outcomes (33). In the 2024–25 academic year, ASM plans to form a second task force that will be dedicated to designing higher (apply, create, evaluate) and lower (know, understand) order measurable learning objectives as examples for faculty to use as they update their courses based on the new fundamental statements.

Because the ASM Curriculum Guidelines were developed in cooperation with educators, a variety of subject matter experts, and stakeholders from around the world, it should be easier for students to transfer their microbiology course credits between 2-year schools and 4-year schools if both are using these guidelines (34). Students wishing to participate in high-impact practices such as internships and study abroad programs should be able to take microbiology at different schools and transfer their credits with confidence as multiple schools adopt similar courses to teach the core microbiology content and skills described in these guidelines.

The updates to the ASM Curriculum Guidelines reflect several changes in both science and society. Scientific techniques have changed substantially since the publication of the 2012 guidelines, as molecular and computational microbiology have become commonplace. Microbiology also plays an important role in society, especially when researching and communicating concepts related to socioscientific issues such as climate change, vaccines, and emergence of novel diseases. The new fundamental statements and skills were designed to guide instructors to teach their students to apply core content and skills, evaluate scientific evidence, and effectively communicate microbiology concepts to a variety of audiences.

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ADDITIONAL FILES

The following material is available online.

Supplemental Material

ASM Curriculum Guidelines (jmbe00126-24-s0001.pdf). Guidelines posted on ASM website March 2024.

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