Antimicrobial resistance (AMR) is an urgent global threat that is receiving unprecedented national and international attention. Resistance caused by bacterial pathogens has become a major focus. Recently there has been an explosion of plans and activities around the issue. There is increasing recognition that no one organization or sector alone can address and solve a problem of this magnitude. Recognizing the significance of AMR across the microbial sciences, the American Society for Microbiology (ASM) is establishing a new initiative to complement existing efforts, facilitate synergy, and provide a mechanism to move projects forward.

The new ASM initiative is a multi-stakeholder mechanism to share information, analyze the current status of AMR with a focus on resistance in organisms causing acute bacterial infections, and identify relevant needs and opportunities for addressing AMR across the microbial sciences. ASM will convene subject-matter experts to review existing knowledge and identify practical, action-oriented solutions to overcome current barriers and maximize the impact on public, animal, and environmental health. Given the breadth of ASM membership and partners, the ASM can serve as facilitator and convener to bring together a multidisciplinary group of stakeholders in a One Health approach to address AMR. The ASM is in a unique position to be able to collaborate and combine expertise among several different initiatives.

James M. Tiedje, Ph.D. (Treasurer, ASM), and James M. Hughes, M.D. (Academy Board of Governors), serve as co-chairs of the Steering Committee for this effort, which includes representation from federal agencies, professional societies, non-governmental organizations (NGOs), academia, and industry (see list last page). The Steering Committee met on August 3, 2016, to identify short- and long-term goals, identify possible initial areas of focus, and identify relevant organizations and experts. The intent is to complement and leverage existing efforts, identify areas where there are currently gaps, and then catalyze additional activities.

Needs and Opportunities

Initial areas of discussion included stewardship and surveillance, environmental issues, clinical issues, and global perspectives. Presented below is a summary of identified needs and potential opportunities for ASM action as discussed by the Steering Committee at the meeting for each of these areas.

NOTE: In this document, “ASM” serves as a placeholder for the ASM in its entirety, a specific ASM program, or a working group of experts, to be determined, depending on which entities will take action.
### Surveillance and Stewardship

#### Needs

1. **Need to expand surveillance** There is a need for robust, standardized surveillance systems incorporating clinical, agricultural, and environmental data at the local, national, and global levels. Surveillance systems can include integration of whole-genome sequencing, phenotypic methods of resistance detection, and consideration of microbial ecological factors driving the spread of AMR. In addition, cooperation and collaboration between public health, environmental, veterinary diagnostic, and clinical labs are needed to share information and incorporate epidemiological data. (See also Point 5 below.)

2. **Need for stewardship across settings** Approaches are needed to optimize antibiotic use in both human and animal settings, including through convening a broad community of stakeholders and identifying stewardship champions.

3. **Need for rapid diagnostics** Rapid diagnostics are needed to guide antimicrobial therapy. It is difficult to implement clinical trials to advance new diagnostics to enable targeted treatment and avoidance of the use of broad-spectrum antibiotics. For diagnostics that are already in use, it would be useful for medical providers and clinical laboratories to have guidance on which tests would be most helpful in a particular clinical situation.

4. **Need for data to guide therapy** Regional antibiograms are needed to provide local susceptibility information to guide empiric antimicrobial therapy. This is needed on the human side and is especially needed for use on smaller, noncorporate agricultural operations or those that may have less frequent interactions with veterinarians.

5. **Need to implement harmonized antimicrobial susceptibility testing (AST) methodology** Leading international agencies have recognized the need for harmonization and provide guidelines for AST. The World Health Organization (WHO) has recommended harmonization of AST methods as a fundamental condition for national surveillance programs for human pathogens. The World Organisation for Animal Health (OIE) includes a similar recommendation for animal pathogens. Using harmonized methodology and interpretive categories, where feasible, can allow for meaningful comparisons of data. The Clinical and Laboratory Standards Institute (CLSI) provides standardized testing documents to support both animal and human pathogens along with interpretive criteria.

#### Opportunities

1. **Expand surveillance** The ASM could work to enhance and complement existing surveillance networks within and outside the United States. Established, culture-based monitoring complemented by newer molecular approaches will provide valuable insights into the routes by which AMR is spreading and the factors influencing the spread. The ASM could work with the Centers for Disease Control and Prevention (CDC) to implement the AR Lab Network, including communicating with clinical labs the importance of sharing isolates and data with public health labs. Within the United States, the ASM could work with the Association of Public Health Laboratories (APHL) to strengthen ties between clinical labs and public health labs; on the international side, the ASM could work with the Transatlantic Task Force on Antimicrobial Resistance (TATFAR), the Food and Agriculture Organization of the United Nations (FAO), OIE, and WHO. In addition, the ASM could work across federal agencies to ensure optimal sharing of surveillance data across platforms and settings, such as the work that is being done connecting the CDC AR Lab Network and the Department of Defense network (Multidrug-Resistant Organism Repository and Surveillance Network at the Walter Reed Army Institute of Research) or connecting human and environmental data through the National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS).

2. **Implement stewardship across settings** A number of initiatives to implement antimicrobial stewardship are currently under way. The ASM could collaborate with ongoing efforts and could promote a team approach
to antimicrobial stewardship programs. In hospitals, this would include infectious disease (ID) physicians, ID pharmacists, and the clinical microbiology laboratory. Rapid feedback and technical expertise from the lab can guide treatment decisions. The ASM could work to fill any gaps in identified best practices to promote stewardship, such as advice for facilities that do not have a clinical microbiology lab or ID expertise on site. Partners in this work could include the Infectious Diseases Society of America (IDSA), the Society for Healthcare Epidemiology of America (SHEA), the American Society of Health-System Pharmacists (ASHP), and the Society of Infectious Diseases Pharmacists (SIDP). In addition, ASM could support and promote work on adapting stewardship practices for use in veterinary settings by working with partners such as the American Veterinary Medical Association (AVMA), the Association of American Veterinary Medical Colleges (AAVMC), and commodity groups with quality assurance programs in place. The ASM could also work to ensure that stewardship principles are included in medical and veterinary school curricula as well as in training for clinical laboratory personnel. ASM has broad-ranging connections and reach into universities and could work to implement curricula already in development (medical, CDC and Wake Forest School of Medicine; veterinary, AVMA).

3. **Promote rapid diagnostics** Rapid diagnostics can allow for better antimicrobial stewardship by providing information on pathogens and susceptibilities to support targeted treatment and minimize usage of broad-spectrum antibiotics. ASM and IDSA have developed *A Guide to Utilization of the Microbiology Laboratory for Diagnosis of Infectious Diseases*. The ASM could participate in ongoing discussions with the clinical community about the use and value of rapid diagnostics and facilitate sharing of best practices among stakeholders.

4. **Collect data to guide therapy** The ASM could engage the wide variety of its membership to create and share antibiograms. The ASM could also serve as an external validator of guidelines regarding antimicrobial therapy in various populations.

5. **Advance implementation of CLSI AST methodology** The ASM could work with the CLSI to promote usage of CLSI methodology and interpretive categories for both animal and human pathogens for national AMR surveillance programs as well as in clinical applications to guide antibiotic decision-making by practitioners. CLSI is in dialog with The European Committee on Antimicrobial Susceptibility Testing (EUCAST), as part of TATFAR recommendations, to seek alignment where possible.

### Environmental Issues

#### Needs

1. **Need for data and risk assessment** More research and surveillance are needed on environmental reservoirs of resistance, resistance transfer, and resistance management strategies. The state of the science is largely exposure assessments; the hazard component of risk assessment and the linkage between environmental reservoirs and animal and human health are not well understood. There can be delayed consequences after exposure; genes can move within populations of commensal and pathogenic bacteria. Coordinated efforts are needed among agricultural, environmental, and human health stakeholders to ensure a One Health approach. As one example, there are not good data on antibiotic use and resistance in animals, especially companion animals.

2. **Need for critical funding to support research and surveillance** Objectives outside of human-related goals in the National Action Plan lack funding. In particular, the U.S. Department of Agriculture (USDA) proposed monitoring and surveillance work that could fill data gaps, but this has not been funded. An organized voice is needed to emphasize the importance of funding for research and surveillance initiatives that are poised to collect needed data.

3. **Need for standardization and modeling studies** With upcoming label changes and requirements for veterinary oversight, there is a need to track changes in antibiotic usage in agriculture. In addition, more modeling studies are needed to demonstrate the impact of antibiotics (and alternatives) on production.
practices. Studies are needed on the intersection between antibiotic usage and antibiotic resistance on farms. Standardization is needed to compare data across studies and settings to the greatest extent possible. This needs to become the foundation for stewardship and judicious, appropriate use guidelines.

4. **Need to engage waste and wastewater stakeholders**

There is a need to engage more with waste and wastewater stakeholders regarding the management of AMR.

5. **Need for short- and long-term solutions**

Considering the global movement of people, food, and water, action needs to be taken quickly to slow the spread of resistance. Data on antibiotic usage patterns in middle- and low-income countries are often missing or of questionable reliability; this is an area in which better information could inform practices to mitigate the spread of AMR. Risk assessment takes time and requires an understanding of risk factors and relationships. Not all key data are currently known or used to inform action. Methods of analysis are not well defined and accepted in the scientific community. Both short- and long-term solutions in the clinical, agricultural, and water and waste management realms are needed to address AMR.

6. **Need for bioinformatics expertise**

Environmental space involves “big data,” and so there is a pressing need for data analysis and interpretation. Different specialties analyzing AMR data, such as molecular genomics, molecular ecology, and epidemiology, may use different terminology; hence, there is a need to bring these groups together when examining data.

7. **Need for commercialization**

There is a need for innovation and commercialization around methods to address AMR. The academic and research communities need to interface with industry and the regulatory community. Intellectual property (IP) protection and government incentives are needed to spur innovation in antibiotic development. Due to market and regulatory pressures, any “bench-to-barn” solutions in the agricultural context must be cost-effective. Alternatives to antibiotics, such as vaccines, can help alleviate the need for antibiotics and are prime candidates for commercialization.

**Opportunities**

1. **Collect data and develop risk assessment**

Addressing AMR in its complexity requires multidisciplinary approaches. The ASM membership comprises a variety of disciplines whose research may address data gaps concerning the environmental spread of AMR. The ASM could work across disciplines to coordinate data collection, share research findings, and develop a risk assessment framework. The ASM could build from existing work (Codex Alimentarius, OIE risk assessment, Joint Programming Initiative on Antimicrobial Resistance) and determine what expertise and models are needed to build risk assessment studies. Partners in this work could include the USDA, the water industry, academic partners, extension networks, and stakeholders working with biosolids, wastewater, and agricultural effluents. The ASM could also offer input on translating research findings into information useful to policy makers and into communications for users, e.g., with the Landgrant University Extension system.

2. **Support critical funding for research and surveillance**

The ASM could provide evidence to build the case for critically needed funding for research and surveillance. The ASM could review the current state of the science to demonstrate what further research is needed, identify priority goals, and determine what the return on investment would be.

3. **Facilitate standardization and modeling studies**

The ASM could facilitate having experienced grant reviewers help with appropriate study design and protocol review for proposed standardization and modeling studies, working with partners such as SCORE (Service Corps of Retired Executives). The ASM could work with ASM Journals on initiatives such as calls for papers or special issues to ensure that gaps are identified and synthesis of existing information occurs.

4. **Engage waste and wastewater stakeholders**

The ASM could take advantage of growing interest and momentum in this area and partner with such entities as the International Water Association (IWA), the Water Environment & Reuse Foundation, the American Water Works Association, and the Environmental Research and
5. **Promote short- and long-term solutions** The ASM could promote concurrent pathways of short- and long-term solutions. The ASM could examine current research to determine what interventions might be adopted quickly, for example, what are discrete “hot spots” of antibiotic resistance on farms, what causes them, and what are cost-effective solutions. On-farm management practices and informed improvements to water and waste management targeted at hot spots could help to minimize the risk of spreading AMR. To the extent possible, the ASM could examine solutions with quantitative impacts. The ASM could also identify potential longer-term solutions while recognizing that there will be more nuances and confounding factors that will affect interpretation. The ASM could partner with the U.S. Environmental Protection Agency (EPA), the USDA, CDC, the National Institutes of Health (NIH), the American Public Health Association (APHA), the Society for Risk Analysis, and epidemiologists. The ASM might convene workshops on AMR with interested stakeholders.

6. **Engage bioinformatics expertise** The ASM could provide leadership and serve as a bridge between various groups to provide bioinformatics expertise for AMR, including the CDC Advanced Molecular Detection initiative, National Institute of Allergy and Infectious Diseases (NIAID)-sponsored sequencing centers, the Department of Energy (DOE) Joint Genome Institute, a number of universities with enhanced big data analysis capacities and programs, and others working on next-generation omics.

7. **Promote commercialization** The ASM could examine the literature for successes in moving compounds through the pipeline and commercializing them. The ASM could foster a spirit of entrepreneurship. The ASM could follow the model of the Society of Environmental Toxicology and Chemistry (SETAC) to engage academics with industry and the regulatory community and partner with universities to advance this effort. Cost-effective commercial alternatives to antibiotics in the agricultural sector (e.g., vaccines) should also be encouraged.

**Clinical Issues**

**Needs**

1. **Need for infection prevention activities** There is a need for educational models and community outreach to increase prevention activities to address AMR. There needs to be more emphasis on the prevention side, to decrease the need to use antibiotics in the first place, especially in terms of engaging clinicians across the board. Of concern is that the “second pipeline” to provide the human resources with expertise to lead prevention programs is running dry. Educational campaigns directed toward the public (e.g., CDC’s “Get Smart”) are also needed.

2. **Need for surveillance to inform prevention** Surveillance data are critical to inform clinical prevention practices.

3. **Need for basic research for antibiotic development** Basic research is needed to advance new therapies as well as diagnostics and alternatives to antibiotics. Data and information sharing will be critical for these endeavors. In addition, funding and resources need to be dedicated to basic research to yield advances.

**Opportunities**

1. **Promote prevention activities** The ASM could collaborate with partners engaged in this work to define educational models and promote infection control and prevention across settings (hospitals, nursing homes, emergency departments, dental settings). The ASM could bring stakeholders together, including infection preventionists and insurers, in strategic partnerships. The ASM could extend successful practice models from medical and veterinary practice settings across other settings.

2. **Use surveillance data to inform prevention** The ASM could work with experts to establish surveillance networks globally and incorporate the data into trainings or toolkits to provide to hospitals, medical schools, and other stakeholders to promote prevention.
The ASM could also be involved in laboratory accreditation and setting new standards to use surveillance as a tool for prevention.

3. **Support basic research for antibiotic development**

The ASM could create connections among ongoing activities, such as the Davos Declaration, the BARDA model, and the CARB-X accelerator. The Pew Charitable Trusts has released *A Scientific Roadmap for Antibiotic Discovery*; the ASM could help implement the roadmap and connect with academic activities. The ASM could provide an inventory of current academic AMR research and initiatives to connect ongoing work and suggest future directions for antibiotic development. Sharing information would be a huge benefit for those working in this space to build from what is known and further the science. Examples of partners to engage include NIH (NIAID), the J. Craig Venter Institute, the Broad Institute of MIT and Harvard, and the University of Maryland. The ASM could continue to support legislation incentivizing antibiotic development. The ASM could also support reimbursement for new diagnostics, looking to other fields, such as oncology, for examples of successful models in supporting reimbursement for molecular diagnostics.

**Global Perspectives**

**Needs**

1. **Need for improved lab capacity** Improved lab capacity and low-cost, rapid diagnostics are needed in low- and middle-income countries to test for antimicrobial resistance of both human and animal isolates.

2. **Need for improved infrastructure** Improved infrastructure is needed to address unwitting contributions to the spread of AMR. Human and animal use of antibiotics is problematic, as is inadequate treatment of wastewater and agricultural effluents.

Middle-income countries may have unique challenges as they have the resources to purchase and use antibiotics but may not have the infrastructure to track and address resistance. Reliable, inexpensive rapid diagnostic tests would make a major difference in addressing AMR in developing countries.

3. **Need for targets and metrics** A list of resistant pathogens of concern on a global scale is needed, similar to the CDC *Antibiotic Resistance Threats in the United States, 2013* (which prioritizes bacteria into one of three categories based on level of concern) or the WHO’s *Antimicrobial Resistance: Global Report on Surveillance* (which identifies nine bacteria of international concern). Anticipated outcomes and metrics are needed to measure progress in addressing these pathogens, including measurements of antibiotic use. Given the scope of the problem, some of these should be intermediate process outcomes, e.g., ensuring that correct methods for culturing are being used.

**Opportunities**

1. **Support improved lab capacity** The ASM could help coordinate lab capacity-building activities related to countries’ national action plans. The ASM could also coordinate with ongoing work that ASM is supporting in a number of countries through the Laboratory Capacity Building (LabCap) program, including surveillance plans, network strengthening, and AST. The ASM could partner with international agencies, universities, academies, and societies. Partnering with international agencies could also address regulation of counterfeit or substandard antibiotics.

2. **Support improved infrastructure** The ASM could bring together stakeholders and support development of new action plans or implementation of existing country-level action plans to improve infrastructure to address AMR. ASM could provide scientists to participate in international workshops and initiatives as management practices and ways to improve infrastructure are discussed. The ASM could work with ASM International Ambassadors to coordinate research and policy agendas. The ASM could work to strengthen existing partnerships, provide technical assistance, and leverage content from domestic efforts. On a broader level, the ASM could also work with international leadership such as Ministers of Finance and at the Ambassador/Embassy level or with the U.S. Department of State. The ASM could monitor outcomes from the United Nations high-level meeting on antimicrobial resistance in September 2016. Due to the global spread of pathogens and resistance, investing in improved infrastructure worldwide is also supporting U.S. homeland security.
3. **Support development of targets and metrics** The ASM could harness its own ongoing international efforts to inform development of meaningful targets and metrics. The ASM could facilitate international data sharing to work towards a representative picture of the issue as well as work with ongoing activities and national action plan development and implementation. Partners in this work could include FAO, OIE, and WHO. This work would be in support of overarching initiatives such as the Global Health Security Agenda, WHO Global Action Plan on Antimicrobial Resistance, and Sustainable Development Goals.

**Conclusion**

AMR is an urgent global problem and will require global solutions. The ASM is well positioned to harness the reach and expertise of ASM members and partners to address current gaps in knowledge and activities and strengthen connections between initiatives to address surveillance and stewardship, environmental issues, clinical issues, and global perspectives.

**Background—Review of the AMR Landscape at ASM**

ASM has long been engaged on issues related to AMR. ASM’s journals, other publications, and meetings reflect the broad range of issues of interest and importance to members. The ASM Task Force on Antibiotic Resistance delivered a report in 1994. The American Academy of Microbiology convened colloquia on antibiotic resistance in 1999 and 2008 and prepared an FAQ Series report on methicillin-resistant *Staphylococcus aureus* (MRSA) in 2013. The Spring 2016 issue of ASM’s *Cultures* magazine focused on AMR. ASM’s Public and Scientific Affairs Board (PSAB) has followed this issue, supporting legislation to address AMR and endorsing the release of the National Action Plan for Combating Antibiotic-Resistant Bacteria (CARB), which included a request for $1.2 billion in funding for action plan implementation, including prevention/stewardship, surveillance, diagnostics, research, and global coordination efforts. Many key papers on AMR have been published recently in ASM journals, including the first report of plasmid-mediated colistin resistance (*mcr-1* gene) in the United States. The ASM Professional Practice Committee is developing a series of webinars on AMR, including susceptibility testing, mode of action, spectrum of activity, and breakpoint detection.

**Meeting Participants**

**Steering Committee members**

James M. Hughes, M.D.—Emory University School of Medicine *(Steering Committee co-chair)*

James M. Tiedje, Ph.D.—Michigan State University *(Steering Committee co-chair)*

Beth Bell, M.D.—Centers for Disease Control and Prevention

Douglas Call, Ph.D.—Washington State University

Gail Cassell, Ph.D.—Harvard Medical School, Brigham and Women’s Hospital, IDRI

Chase Crawford, DVM—Association of American Veterinary Medical Colleges

Larry Granger, DVM—U.S. Department of Agriculture

Alita Miller, Ph.D.—Entasis Therapeutics

Barbara Murray, M.D.—UTHealth *(not in attendance at meeting)*

Stephen Ostroff, M.D.—Food and Drug Administration

Amy Pruden, Ph.D.—Virginia Tech

Thomas Shryock, Ph.D.—Antimicrobial Consultants, LLC

Randy Singer, DVM, MPVM, Ph.D.—University of Minnesota *(remote)*

Kathy Talkington—The Pew Charitable Trusts

Ed Topp, Ph.D.—Agriculture and Agri-Food Canada *(remote)*

**Speakers**

David Hooper, M.D.—Massachusetts General Hospital

Randy Singer, DVM, MPVM, Ph.D.—University of Minnesota *(remote)*

**Note:** This meeting summary was prepared by Virginia Dolen, Program Manager, American Academy of Microbiology. It was reviewed by the Steering Committee co-chairs to ensure accuracy, and all Steering Committee members had the opportunity to provide feedback. The identified needs and opportunities reflect the views of the participants and are not intended to reflect official positions of the Academy or ASM.

This document is intended to summarize the discussion that occurred at the August 3, 2016, Steering Committee meeting. For more information on the ASM AMR Steering Committee, please contact Marina Moses, Director of the American Academy of Microbiology (202-942-9227, mmoses@asmusa.org), or Connie Herndon, Director of Strategic Alliances (202-942-9327, cherndon@asmusa.org).