



Microbiomes of the Built Environment: A Research Agenda for Indoor Microbiology, Human Health, and Buildings

RECAP OF RESEARCH AGENDA

Characterize Interrelationships Among Microbial Communities and Built Environment Systems of Air, Water, Surfaces, and Occupants

1. Understand relationships among building site selection, design, construction, commissioning, operation, and maintenance; building occupants; and microbial communities.
2. Incorporate social and behavioral sciences to analyze the roles of the people who occupy the built environment.

Assess the Influences of the Built Environment and Indoor Microbial Exposures on the Composition and Function of the Human Microbiome, on Human Functional Responses, and on Human Health Outcomes

3. Using complementary study designs—observational, animal model, and intervention—to develop and test health-specific hypotheses.
4. Clarify effects of timing (stage of life), dose, and differences in human sensitivity on relationships among microbial exposures and health.
5. Develop exposure assessment approaches to address how combinations of exposures (microbial agents, chemicals, and physical materials) influence human functional responses and health outcomes.

Explore Nonhealth Impacts of Interventions to Manipulate Microbial Communities

6. Understand energy, environmental, and economic impacts of interventions that modify microbial exposures and integrate data into frameworks for assessing potential interventions.

Advance the Tools and Research Infrastructure for Addressing Microbiome-Built Environment Questions

7. Refine molecular tools and methods for elucidating identity, abundance, activity, and functions of the microbial communities to enable more quantitative, sensitive, and reproducible experimental designs.
8. Refine building and microbiome sensing and monitoring tools.
9. Develop guidance on sampling and exposure methods for testing microbiome-built environment hypotheses.
10. Develop a data commons with data description standards and provisions for data storage, sharing, and knowledge retrieval.
11. Develop empirical, computational, and mechanistic modeling tools to improve understanding, prediction, and management of microbial activities in built environments.

Translate Research Into Practice

12. Support effective communication and engagement to convey microbiome-built environment information to audiences, including professional building design, operation, and maintenance communities; clinical practitioners; and building occupants and homeowners.

KNOWLEDGE GAPS IDENTIFIED BY THE REPORT

Microbiology / Microbial Ecology

- Improve understanding of “normal” microbial ecology in buildings of different types and under different conditions.
- Improve understanding of how building attributes are associated with microbial communities, and establish a common set of building and environmental data for collection in future research efforts.
- Clarify the association of building attributes and conditions with the presence of indoor microorganisms that have beneficial effects.

Public Health

- Improve understanding of the transmission and impacts of infectious microorganisms within the built environment.
- Clarify the relationships between microbial communities that thrive in damp buildings and negative allergic, respiratory, neurocognitive, and other health outcomes.
- Elucidate the immunologic, physiologic, or other biologic mechanisms through which microbial exposures in built environments may influence human health.
- Gain further understanding of the beneficial impacts of exposures to microbial communities on human health.
- Develop an improved understanding of complex, mixed exposures in the built environment.
- Design studies to test health-related hypotheses, drawing on the integrated expertise of health professionals, microbiologists, chemists, building scientists, and engineers.

Building Science, Operation, and Maintenance

- Collect better information on air, water, and surface microbiome sources and reservoirs in the built environment.
- Develop means to better monitor and maintain the built environment, including concealed spaces, to promote a healthy microbiome.
- Deepen knowledge on the impact of climate and climate variations on the indoor environment.
- Further explore the concept of interventions that promote exposure to beneficial microorganisms, and whether and under what circumstances these might promote good health.

Research Infrastructure

- Develop the research infrastructure in the microbiome–built environment–human field needed to promote reproducibility and enhance cross-study comparison.
- Develop infrastructures and practices to support effective communication and engagement with those who own, operate, occupy, and manage built environments.
- Obtain additional data necessary to support the use of a variety of quantitative frameworks for understanding and assessing built environment interventions.

