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# Frontiers in bacteriology: Challenges and opportunities

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It is a *Frontiers* tradition to herald the start of a new journal with an editorial that highlights the challenges and opportunities of the relevant field. For *Frontiers in Bacteriology*, the start of the journal coincides with a pivotal era for the field, with the slow-moving epidemic of antimicrobial resistance threatening medical progress.

## KEYWORDS

bacteriology, medical progress, antibacterial resistance, medicine discoveries, one health (OH) - approach

## Bacterial drug resistance and the challenges ahead

Antibacterial agents, combined with infection prevention measures, have allowed for medical treatments and procedures, such as cancer chemotherapy and transplantation. These breakthroughs have resulted in a sharp rise in life expectancy (Hutchings et al., 2019). Microbial resistance can undermine all Medicine discoveries (World Health Organization, 2022). Our current approach is centered on leveraging chemical compounds that target bacterial pathways. However, bacteria have shown that they can overcome these treatments, and we are starting to understand the long-term effects of these treatments to cross-kingdom interaction and the microbiome. The challenge of bacterial drug resistance can only be addressed through a multidisciplinary approach that moves outside of silos.

## Bacteriology is a One Health Science

Bacteriology impacts food safety and health equity (Lambraki et al., 2022; Shurson et al., 2022) and we are coming to appreciate that bacteriology and the challenge of antimicrobial resistance is a One Health challenge (World Health Organization, 2017), where veterinary treatments, use of antibacterial agents in aquaculture and agriculture, and environmental factors (including climate change) all affect the bacterial world and

the development of resistance. As humans, we are guests in an environment that is shaped by microorganisms. Even within our own bodies, our cells are a minority compared to our different microbiota and especially bacteria. The interplay between host, bacteria, and the environment is dynamic and continual and we also have a permanent effect in the bacterial world (for example, consider for a second the effects of hospital wastewater or the use of antibacterial agents for human activities). In this context, expanding our thinking about bacteriology should also include studies that help advance health equity and help alleviate inequity (Mitnick et al., 2016).

## A new approach to antibacterial discovery

Historically the role of bacteria was mostly investigated in the context of disease. However, as we realize the impact of the microbiome in overall health, future studies in bacteriology will need to evaluate the impact of broadly defined dysbiosis (an imbalance between the types of organism present in a host's natural microflora) (Naylor et al., 2018). Understanding vaccine development and the use of bacteria as probiotics or as part of treatments to combat cancer or other infections (Sedighi et al., 2019) also requires deep understanding of bacterial immunity and the evolution of virulence traits and immune responses. Moreover, we are discovering the complex role of the microbiome in controlling resistant pathogens and how it influences the immune system, metabolism, and a range of gastrointestinal conditions (Zheng et al., 2020).

This complex challenge also includes a renewed approach in antimicrobial drug discovery with whole animal testing and the advancement of novel approaches such as anti-virulence agents (Fleitas Martinez et al., 2019) and phages (Brives and Pourraz, 2020), as well as immunomodulatory agents that enhance and regulate the immune system to fight infection (Pirofski and Casadevall, 2006; Fura et al., 2017). This new approach in antimicrobial drug discovery can draw on new mammalian and non-mammalian model hosts, artificial intelligence (AI, machine learning approaches), mathematical modelling, and a personalized approach to bacterial prophylaxis and treatment that could include genomic analysis of the host, the pathogen, and the microbiome.

## Changing our approach to antibacterial therapy

Clinical medicine also needs to change as we develop new tools to identify bacteria and novel approaches to combat diseases. The role of Microbiology and Infectious Disease needs to evolve in an era with rapid diagnostics and AI-aided

evaluation of large data which minimize the use of “empiric therapy” and allow for a personalized approach to antibacterial prophylaxis and treatment (Corbin et al., 2022). Selection of optimal treatment and development of clinically reliable biomarkers for response to treatment are needed. The role of providers needs to extend from providing treatment against a specific pathogen, and focus on providing timely, minimal, and effective treatment as well as the recovery of a healthy microbiome and eubiosis (microbial balance within the body). In this context, there is growing interest in steps to restore the microbiome after an infectious disease and its treatment. Importantly, antibacterial therapy, infection prevention, and antimicrobial stewardship need to be considered in the continuum of care, and encompass outpatient, acute, and long-term care, including nursing homes.

Addressing the slow-moving pandemic of bacterial resistance requires a revamped and realistic approach to antimicrobial drug discovery and a requires a complete rethinking of the antimicrobial market chain that includes early concepts, screens, hit to lead development, and every step included in the development of new antibacterial therapies. This is particularly urgent as most large pharmaceutical companies have moved out of this market, and smaller companies cannot survive even when they have a product that makes it through regulatory approval, new incentives, and a complete reevaluation of the market that includes cross-border cooperation, smart incentives, and rewards linked to availability and not the use. The bankruptcy of Achaogen and other similar failures are well documented and remind us that the antibacterial market needs to be revisited (Jit et al., 2020; Aagaard et al., 2021) towards a framework that provides a positive collaboration between academia and the pharmaceutical industry.

## An inter-disciplinary forum for bacteriology

To address these challenges, the field can benefit from an inter-disciplinary forum that encompasses all different One Health disciplines and provide a forum for the reporting of studies evaluating all aspects of bacteriology and the complex dynamic of host-pathogen interactions. *Frontiers in Bacteriology* aims to become such a forum. We aim to publish rigorously peer-reviewed novel and cutting-edge research across the entire spectrum of bacteriology, including pathogenesis, immune response (including evolutionarily conserved traits), vaccine development, microbial resistance, beneficial bacterial interactions (such as in the context of microbiome and probiotics), cross-kingdom interactions, as well as translational and clinical studies on population health, diagnosis, treatment, cost-effectiveness models, and antimicrobial stewardship.

Supported by an outstanding Editorial Board of international researchers who cover all aspects of molecular and clinical

bacteriology, *Frontiers in Bacteriology* multidisciplinary open-access journal is at the forefront of disseminating and communicating scientific knowledge and impactful discoveries to researchers, clinicians, and the public worldwide. Using a system that allows for transparent peer review, we envisage a forum for high-level research on all bacterial phyla and all different conditions such as biofilms, and persister or tolerant forms (Yan and Bassler, 2019). In addition to the field of bacterial pathogenesis, host response, and vaccine and drug discovery, the journal also welcomes reports on human and veterinary bacterial infections, all pathogens (including mycobacteria, *Helicobacter pylori*, etc.), and interactions of bacteria with bacteriophages. Also, we seek studies on clinical infectious diseases in the continuum of care (including in the community and non-acute health care), as well as studies focusing on relevant vaccines, veterinary medicine, or the role of non-pathogenic and beneficial bacteria as parts of the microbiome or their use as probiotics.

## The challenge for the field and the role of *Frontiers in Bacteriology*

In order to preserve the medical advances of our era, we need to address the challenge of microbial drug resistance and the need for a balanced bacteriome. This new era of bacteriology requires a multifaceted approach that includes studying cross-kingdom interactions and the use of novel antibacterial approaches that include immune modulation, phage, and anti-virulence assays. *Frontiers in Bacteriology* aims to provide a forum for this new era in bacteriology by publishing all One Health research related to the role of bacteria. We understand the challenges that authors go through in order to prepare their manuscript and we hope to provide a home for innovative research on the global impact of bacteria, highlighted aspects of evolutionarily preserved traits of host-bacteria interactions,

bacterial vaccinology, policy and public health measures, emerging bacterial threats, the impact of climate change, molecular real time clinical diagnostics (including medical, veterinary, aquaculture, and agriculture), and discoveries in antimicrobial drug discovery and stewardship.

## Author contributions

Each author who contributes to *Frontiers in Bacteriology* will be paving the way to progress in light of the challenges we now face concerning antimicrobial resistance. The journal welcomes a range of approaches, turning to the innovative and novel in order to tackle the changing bacterial landscape and ensure we all live healthy lives on a healthy planet. The author confirms being the sole contributor of this work and has approved it for publication.

## Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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