

Transmission of bacterial resistance genes in aerosols

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Summary

- Investigate how bacteria carrying genes for antibiotic resistance spread through the aerosol and what factors influence the spread of these bacteria through the air, employing the innovative CELEBS technology.
- Enhance our comprehension of the factors that influence the dynamic of gene uptake by bacteria in air, providing strategies for mitigating the dissemination of antibiotic resistance dissemination in aerosols.

Introduction

- Abuse of antibiotics leading to the rise of antibiotic resistance (AMR), becoming a global health concern.
- Airborne ARGs, exhibit a broader transmission range and diverse sources^[1], are affected by many factors, pose a threat to human and animal health^[2].
- Little investigation to identify the process of ARGs transmission in the aerosol directly.

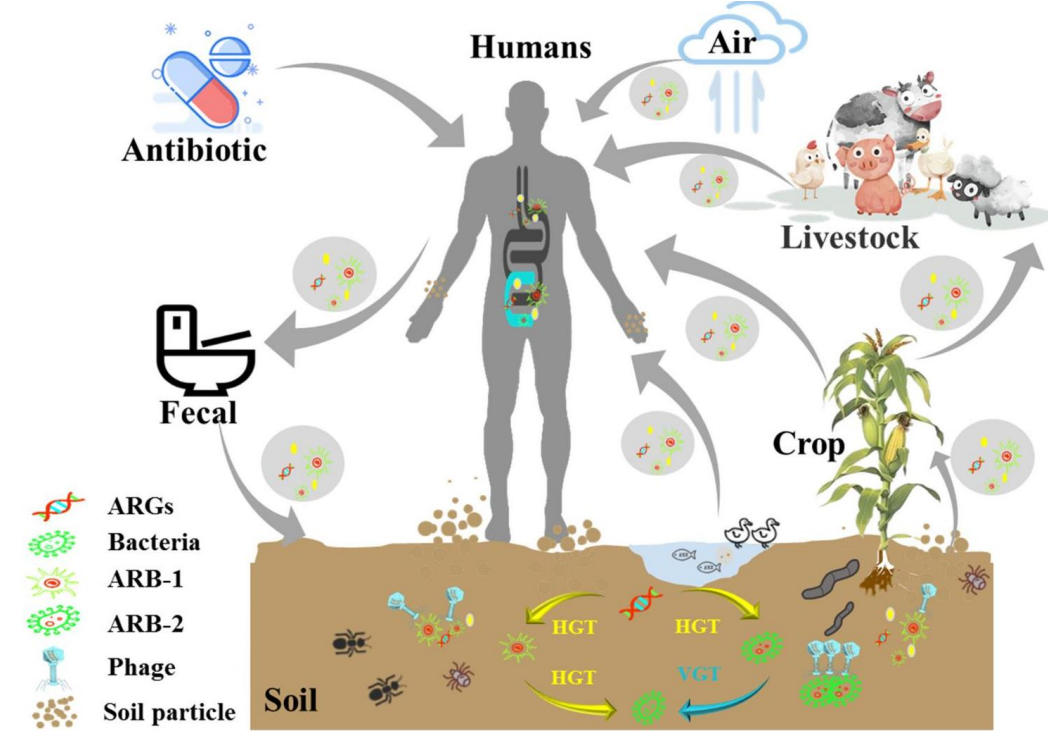


Figure. 1 Transmission of antibiotic resistance genes^[1]

Objectives

- Demonstrate that the high salt concentration in a droplet, coupled with its rapid dilution following deposition into a solution, will mitigate gene uptake by the bacteria present.
- Explore the fundamental processes that limit and accelerate this process, variables such as salt type, environmental relative humidity, and aerosol dispersal time.

Methods

Preparation of competent bacterial cells and bacterial transformation

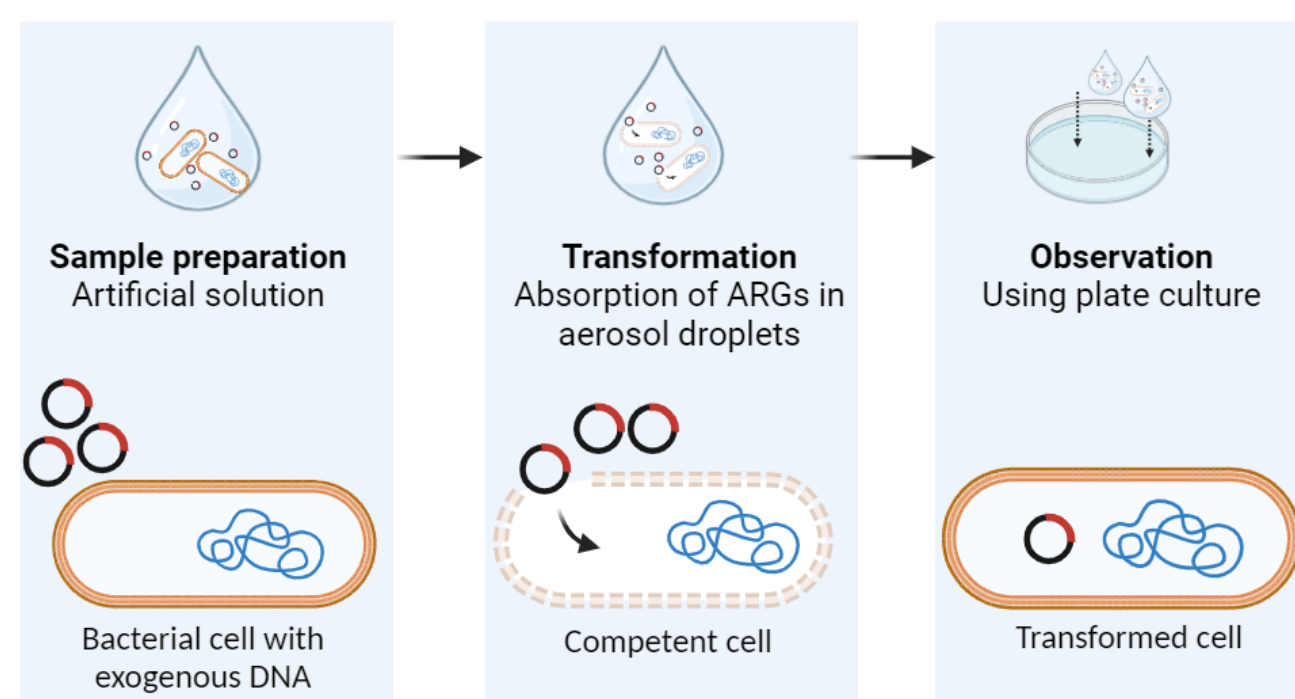


Figure. 2 Diagram of chemical transformation process in aerosol

- Competent cells are cells that have been treated to can take up exogenous DNA more easily and can induce corresponding changes in genotype and phenotype^[3].
- Step 1: Prepare for the plasmid with ARGs and target bacterial.
- Step 2: E.coli treated with Ca²⁺ solution becomes cells that are easily transformed by plasmid DNA, ARGs are mixed with competent cells.
- Step 3: Using laboratory technique to observe the transfer of genetic information and the appearance of new heritable traits in the cells.

Controlled electrodynamic levitation and extraction of bioaerosol onto a substrate (CELEBS)

- Produce and levitate a population of aerosol particles (1 to >100) containing a known number of microorganisms (1 to >1000) with known (and indeed chosen) chemical and biological composition in a highly-controlled environment.

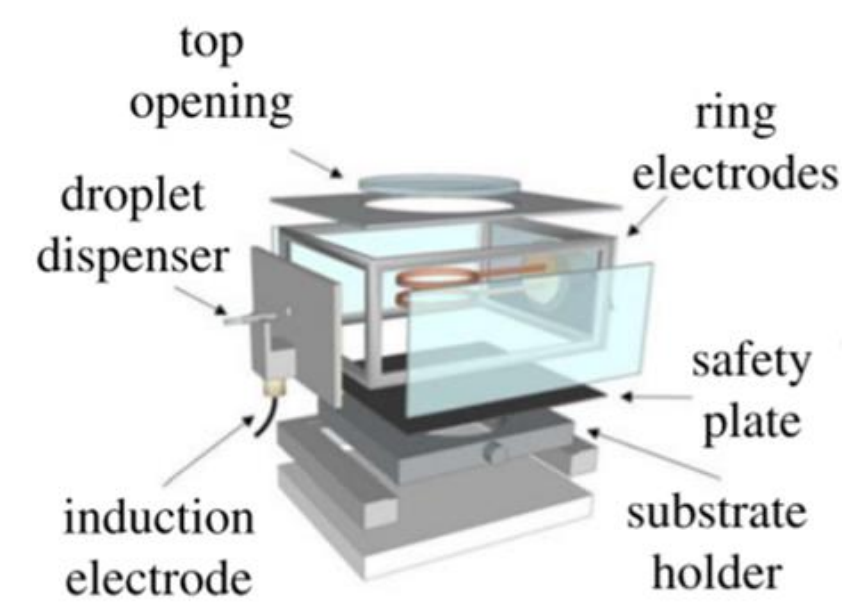


Figure. 3 Schematic diagram of main components of the CELEBS apparatus^[4]

- Probe microbe viability in the air as a function of environmental factors.
- In this study, CELEBS is used to quantify ARGs transfer in the aerosol phase, provide evidence of ARGs in aerosol uptake by bacteria is quantified, aiming to identify the parameters.

Antimicrobial susceptibility testing (AST)

- Identify bacterial strains that carry resistance genes against specific antibiotics by testing aerosol samples.

Disk Diffusion Method (Kirby-Bauer Method)

- Step 1: the isolated bacterial colony is selected, suspended into growth media, and standardized through a turbidity test.
- Step 2: the standardized suspension is then inoculated onto the solidified agar plate, and the antibiotic-treated paper is tapped on the inoculated plate. The disc containing the antibiotic is allowed to diffuse through the solidified agar, resulting in the formation of an inhibition zone after the overnight incubation at 35 °C.
- Step 3: the size of the inhibition zone formed around the paper disc is measured; the size of the inhibition zone corresponds to the concentration of antibiotic.

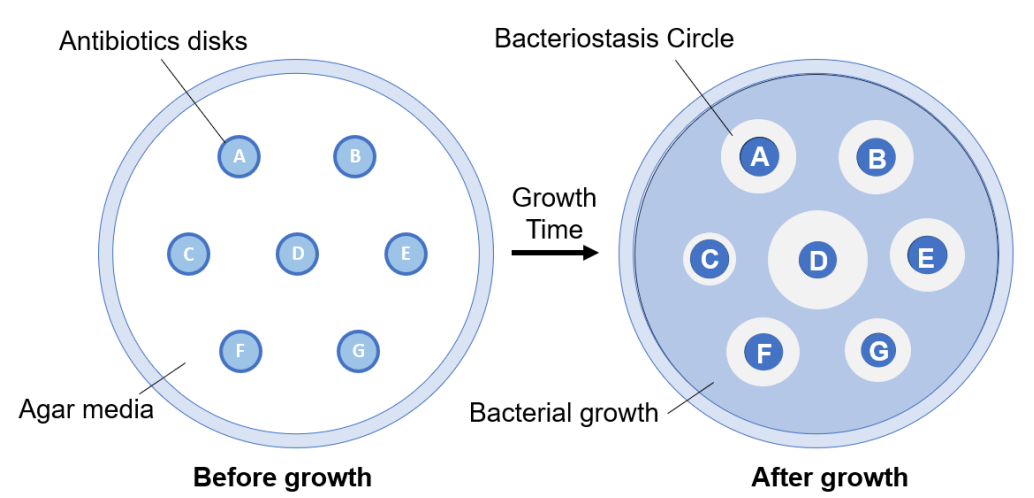


Figure. 4 Diagnostic diagram of the disk diffusion agar method test

Anticipated outcomes

- Uncover the fundamental mechanism underlying bacterial resistance gene transmission in aerosol.
- Elucidate the potential of aerosols to facilitate the spread of bacterial resistance genes, thereby contributing to combat the amplification and perpetuation of antibiotic resistance.
- Understand the roles of aerosol in AMR transmission in human, animal and global ecosystems.
- Aid in the prevention of the airborne spread of pathogens or source identification with the knowledge of the transportation of bacteria by air currents.

Reference

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