Specificity and diversity of fungal-bacterial interactions

Norio TAKESHITA

University of Tsukuba, Faculty of Life and Environmental Sciences, Microbiology Research Center for Sustainability(MiCS)

Report: Exclusivity in physical spaces and nutrients is a prerequisite for the survival of organisms, but a few species have been able to develop mutually beneficial strategies that allow them to co-habit. We discovered a mutualistic mechanism between the filamentous fungus, *Aspergillus nidulans* and the bacterium, *Bacillus subtilis* (Abeysinghe et al 2020). The bacterial cells co-cultured with the fungus traveled along the mycelia using their flagella and dispersed farther with the expansion of the fungal colony, indicating that the fungal mycelia supply space for the bacteria to migrate, disperse and proliferate. Transcriptomic, genetic, molecular mass and imaging analyses demonstrated that the bacteria reached the mycelial edge and supplied thiamine to the growing hyphae, which led to a promotion of hyphal growth. The transfer of thiamine from bacteria to the thiamine non-auxotrophic fungus was directly demonstrated by stable isotope labeling. The simultaneous spatial and metabolic interactions reveal a mutualism that facilitates the communicating fungal and bacterial species to obtain an environmental niche and nutrient, respectively.

Research objectives

Bacteria and fungi comprise a large fraction of the biomass in soil. Since they interact with each other to carry out their characteristic functions in the ecosystem, a better knowledge of bacterial-fungal interactions is important to understand the microbial ecosystem, which is closely related to agriculture, medicine, and the environment. This project aimed to reveal the inter-kingdom interactions through diverse factors such as antibiotics, signaling molecules, cooperative metabolism, and physical interactions.

Methods

We co-cultured a model filamentous fungus, *Aspergillus nidulans* and the bacterium, *Bacillus subtilis* on agar plates. Their spatial and metabolic interactions were analyzed through transcriptome, genetic, molecular mass and imaging analyses.

Results

The bacterial cells co-cultured with the fungus travel along the mycelia depending on their flagella and disperse with the expansion of the fungal colony, indicating that the fungal mycelia supply space for bacteria to migrate, disperse and proliferate. Transcriptome, genetic, molecular mass and imaging analyses demonstrate that the bacteria reach the mycelial edge and supply thiamine to the growing hyphae, resulting in a promotion of hyphal growth. The transfer of thiamine from the bacteria to the thiamine non-auxotrophic fungus is directly demonstrated by stable isotope labeling.

Conclusion

The simultaneous spatial and metabolic interactions reveal a mutualism that facilitates the communicating fungal and bacterial species to obtain an environmental niche and nutrient, respectively.

References

Abeysinghe, G., Kuchira, M., Kudo, G., Masuo, S., Ninomiya, A., Takahashi, K., Utada, A. S., Hagiwara, D., Nomura, N., Takaya, N., Obana, N., Takeshita, N. (2020) Fungal mycelia and bacterial thiamine establish a mutualistic growth mechanism. *Life Science Alliance*. 3, 12, e202000878. DOI: 10.26508/lsa.202000878