Graduate School Event

Thesis Defense: The Role of Genetic Background in Bacterial Adaptation

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Host: Johannes Fink

Bacterial adaptation depends not only on the selective environment but also on the genetic background that determines which variants can arise and how they affect fitness. This thesis investigates how genetic background affects bacterial adaptive capacity by experimentally examining the effect of insertion sequence (IS) elements activity and establishing a strain system for future experiments to reveal the role of natural competence.The main experimental study compared Escherichia coli MG1655 with a derivative lacking all 45 chromosomal IS elements, together with additional strains designed to separate the effects of IS removal from restoration of the IS-disrupted gene wbbL. Replicate populations were adapted to increasing concentrations of a five-antibiotic mixture and to each antibiotic individually, and their adaptive responses and evolutionary routes were compared. Under mixture selection, IS-containing and IS-free populations reached similar endpoint resistance and acquired similar numbers of mutations, although their mutation spectra differed significantly. IS-driven mutations were rare, indicating that IS activity contributed little to adaptation under this condition. Adaptation to individual antibiotics produced larger treatment-specific resistance gains and more recurrent mutations in the same loci across independently evolved populations than adaptation to the antibiotic mixture. The contribution of IS-driven mutations varied among antibiotics and was highest under tetracycline selection. Under tetracycline treatment, IS-containing populations adapted faster and reached higher selection concentrations than IS-free populations. Inactivation of wbbL partially restored the adaptive capacity of the IS-free strain but did not fully eliminate the difference, while IS-containing populations repeatedly accessed IS-mediated mutations unavailable to the IS-free strains.Earlier experiments examining adaptation to ethanol, sodium chloride, and butanol did not provide reliable evidence for differences between the IS backgrounds. Growth observed at high sodium chloride and butanol concentrations during selection was not retained after stress-free recovery, whereas turbidostat-based ethanol experiments revealed technical limitations of using the device for parallel long-term evolution. These results motivated the more robust antibiotic-selection design. Finally, an experimental framework was developed to test whether natural competence contributes to the adaptive capacity of Bacillus subtilis. As a first step toward the proposed experiments, a genotypically verified ΔcomEC strain and characterized fluorescent strains were constructed, but the evolution experiments remain to be initiated.Together, these results show that IS elements can expand the repertoire of accessible mutations without conferring

a universal adaptive advantage. Whether IS activity improves adaptation depends on the selective environment, the wider genetic background, and whether IS-mediated mutations provide particularly beneficial adaptive routes.

Tuesday, September 1, 2026 11:00am - 12:00pm

Central Bldg / O1 / Ballroom (I01.O1.006) and Zoom

This invitation is valid as a ticket for the ISTA Shuttle from and to Heiligenstadt Station. Please find a schedule of the ISTA Shuttle on our webpage: https://ista.ac.at/en/campus/how-to-get-here/ The ISTA Shuttle bus is marked ISTA Shuttle (#142) and has the Institute Logo printed on the side.