Living on acetate without glyoxylate cycle

The glyoxylate cycle represents an efficient strategy for acetate conversion in biomass present in bacteria, protists, algae, plants, and fungi. However, during the last 15 years several metabolic solutions have been described that explain how microorganisms can grow with acetate as the sole source of C despite the absence of the two key enzymes for the glyoxylate bypass: isocitrate lyase (EC 4.1.3.1) and malate synthase (EC 2.3.3.9). Stoichiometric models inferred from complete genomic sequences are useful and robust computational tools for in silico, systemic approaches to metabolic networks. We have recently identified two bacteria capable of living on acetate as the sole C source without glyoxylate cycle: the phytopathogen Xylella fastidiosa and the polyextremophilic bacterium Exiguobacterium sp. Helios. Our genome-scale computational models predict that both bacteria produce biomass from acetate using metabolic solutions different from each other and different from those described so far. These findings have encouraged us to conduct a comprehensive study of the phylogenetic distribution of the ability to grow on acetate and the analysis of the diversity of metabolic strategies for the conversion of acetate to gluconeogenic precursors. We observe a widely distributed functional degeneracy for this phenotypic trait and discuss the implications on the discovery of the multiplicity of pathways that, beyond the glyoxylate cycle, make it possible to live on acetate in the microbial world.