GORDON AND BETTY MOORE FOUNDATION

Team Karl Highlight

Are microbes picky eaters?

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Growth of heterotrophic microbes requires the extraction of energy, electrons, carbon, and nutrients from a complex and dynamic reservoir of potential substrates. We employed a matrix of selected organic substrates with varying characteristics, and experimentally followed the kinetics of assimilation and respiration to explore the basic principles that govern selection and preferential use based on carbon, nitrogen, and energy content. We further competed these substrates in a combinatorial fashion to evaluate preferential substrate utilization in natural microbial assemblages. Several substrates displayed biphasic kinetic responses and variable respiration:assimilation ratios. Amino acids had the shortest turnover times and were taken up preferentially at ambient concentrations. We also identified a linear relationship between substrate uptake rates and affinity (Figure 1), suggesting the microbial community optimizes the relative abundances of membrane transporters according to substrate demand. When competed against one another at saturating concentrations, substrate assimilation and respiration rates were enhanced or inhibited by up to two orders of magnitude, compared to competitor-free controls (Figure 2), Further, we describe an unexpected trend between the substrate energy density and turnover times, with more energetic, reduced carbon substrates turning over more slowly than more oxidized substrates.

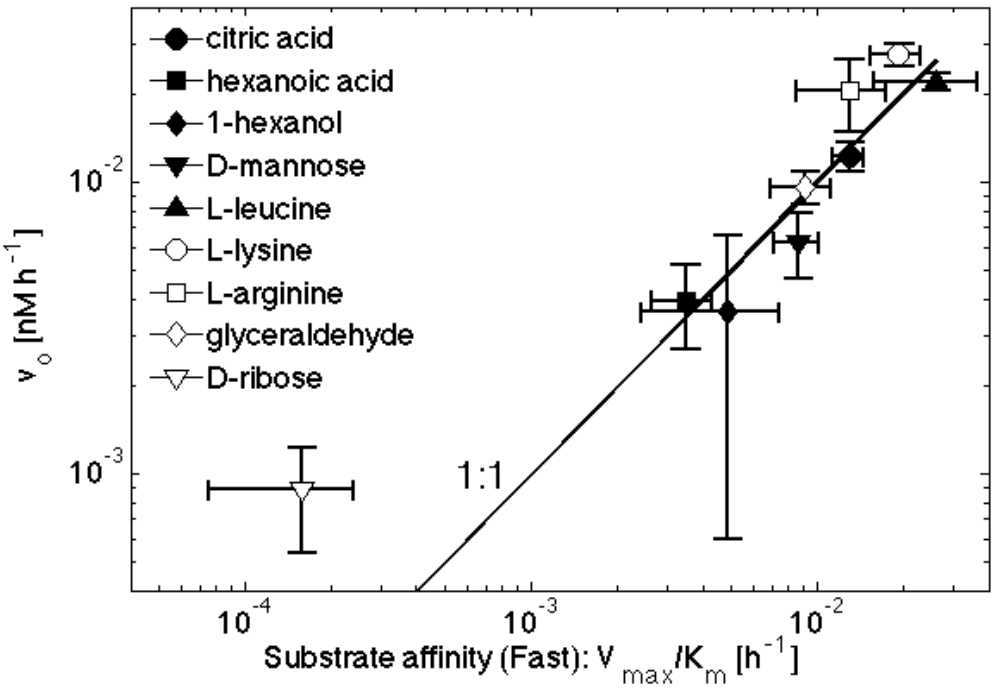

Figure 1. Ambient substrate uptake rates (v_0) as a function of substrate affinity (a_F^0). Error bars represent one standard deviation for both variables. Values are plotted with the line of unity for

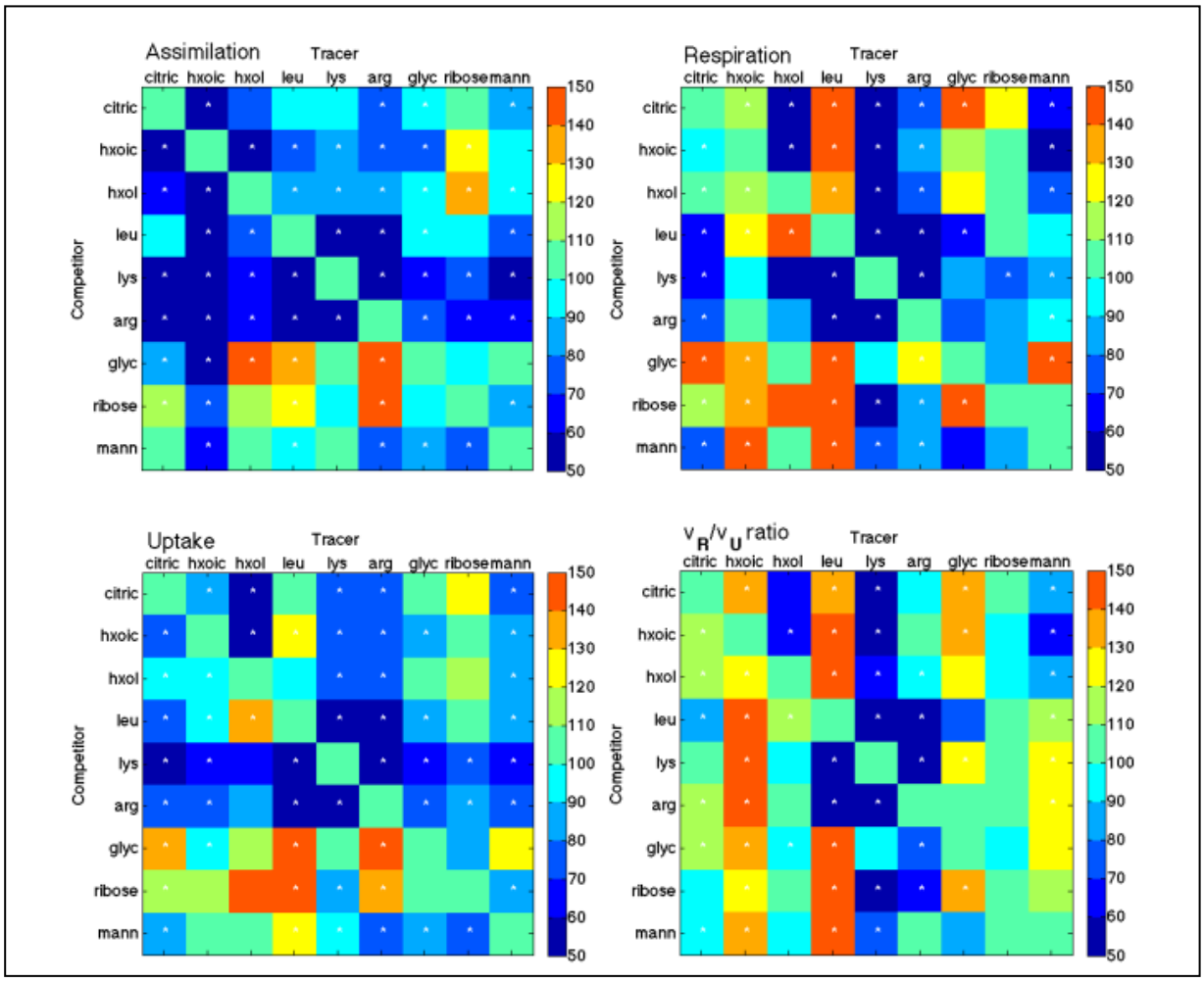

Figure 2. Summary of competition experiments. Colors represent relative % change compared to control (the diagonal is defined as unity, 100%). Symbols represent significant (p<0.05; Student's t-test) Substrate names are abbreviated for clarity: *cit* – citric acid, *hxoic* – hexanoic acid, *hxol* – 1-hexanol, *leu* – L-leucine, *lys* – L-lysine, *arg* – L-arginine, *glyc* – glyceraldehyde, *ribose* – D-ribose, *mann* – D-mannose.