

## Quantitative principles in biological systems

### Problem Set #4

Due by noon on 2026/06/04

1. Evolutionary dynamics: Recall from our class on protein sequences that the co-variation between residues at two sites can contain information about direct contacts and other co-evolutionary signals. We discussed the idea that a mutation at one site can destabilize the contact, which can be stabilized again by a mutation at the co-varying site. This picture implies a fitness valley crossing, since the destabilizing mutation is likely deleterious. Please discuss how you might estimate the feasibility of this process, including what quantities to calculate and what model proteins you might analyze.
2. Ecological dynamics: The file `eco_data.xlsx`<sup>1</sup> contains species abundances from two experiments in which a rotifer species (predator) and an alga species (prey) are co-cultured together. Can you model the resulting dynamics using the predator-prey models discussed in class? Explain your reasoning. Are there any notable differences between the two experiments?
3. Final project: Present a progress update in class to get feedback.

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<sup>1</sup> From Yoshida et al. *Nature* (2003)