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Disentangling the interaction among energy, immunity, and pathogens

The interaction between the immune system and pathogens is often characterised as a predator-prey interaction. This characterisation ignores the fact that both require host resources to reproduce. Here, we propose novel theory that considers how these resource requirements can modify the interaction between the immune system and pathogens. We derive a series of models to describe the energetic interaction between the immune system and pathogens, from fully independent resources to direct competition for the same resource. We show that increasing within-host resource supply has qualitatively distinct effects under these different scenarios. In particular, we show the conditions for which pathogen load is expected to increase, decrease or even peak at intermediate resource supply. We survey the empirical literature and find evidence for all three patterns. These patterns are not explained by previous theory, suggesting that competition for host resources can have a strong influence on the outcome of disease.