The human CO2 production (9 giga ton/y) is small compared to the natural emissions (60+60+90), and the natural buffers. Why then do we observe such a large increase in atmospheric CO2 levels?
This epidemic can be described with a classic SIR model,

\[
\frac{dS}{dt} = -\beta S \frac{I}{N}, \quad \frac{dI}{dt} = \beta S \frac{I}{N} - (d + r)I \quad \text{and} \quad \frac{dR}{dt} = rI,
\]

Fit this SIR model to the data to learn something about the longevity of the immunity to SARS-CoV-2. They also present data on the percentage of seroconverted individuals when the medium is not diluted when the medium is refreshed.
Metabolic Trade-Offs Promote Diversity in a Model Ecosystem

Anna Posfai, Thibaud Taillefumier, and Ned S. Wingreen

Motivated by recent studies of phytoplankton, we introduce trade-offs into a resource-competition model and find that an unlimited number of species can coexist. Our model spontaneously reproduces several notable features of natural ecosystems, including keystone species and population dynamics and abundances characteristic of neutral theory, despite an underlying non-neutral competition for resources.
Why are some pathogens more virulent than others? Theory predicts that pathogens that ‘keep their host alive’ can sometimes outcompete virulent pathogens in times when transmission to new susceptible hosts is unlikely. Yet, this prospect of finding a new susceptible host changes itself throughout an epidemic. In the early stage of an epidemic, susceptible hosts are abundant and virulent pathogens that invest more into horizontal transmission should win the competition. Later on, the spread of the infection reduces the pool of susceptible hosts and may reverse the selection on virulence. This may favor benign pathogens after the acute phase of the epidemic. To put these predictions to the test we monitor the competition of the temperate bacterial virus λ and its virulent mutant λcI857 in experimental epidemics. Our experimental results agree remarkably well with all our theoretical predictions.
Competitive exclusion and parasitism (Q10.2)

We studied the effect of a pathogen on winning species:

\[ S'_j = bN_j (1 - N_j / k) - d_j S_j - \beta S_j I_j \]

\[ I'_j = \beta S_j I_j - (d_j + \delta) I_j \]

Janzen-Connell hypothesis: parasites evolve towards most dominant species (negative density dependence) [Bagchi et al., Nature, 2014]

What is the effect of pathogens on co-existence?
Symmetry breaking in ecological systems through different energy efficiencies of juveniles and adults

Ontogenetic development for dummies, try to repeat these results with:

\[ R = K - c_1 J - c_2 A \]
\[ \frac{dJ}{dt} = \frac{eAR}{h_2 + R} - \frac{mJR}{h_1 + R} - \mu d_1 J \]
\[ \frac{dA}{dt} = \frac{mJR}{h_1 + R} - \mu d_2 A \]
Early-warning signals for critical transitions (Q11.2)

Test whether or not this works in “real-world” example of models for grazing in Sahel zone.
Intermediate levels of vaccination coverage may minimize seasonal influenza outbreaks

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Our models predict that the total number of seasonal influenza infections is minimized at an intermediate (rather than maximal) level of vaccination, and, somewhat counter-intuitively, further increasing the level of the vaccination coverage may lead to higher number of influenza infections and be detrimental to the public interest.
Cryptic oscillations (Q 5.7).

Effect of Prey Heterogeneity on the Response of a Model Food Chain to Resource Enrichment

\[ \frac{dC}{dt} = (C_0 - C)\omega - [\varepsilon N\psi C/(K + C)] - [\varepsilon_R R\psi_R C/(K_R + C)], \]
\[ \frac{dN}{dt} = N\psi C/(K + C) - \alpha NP - \omega N, \]
\[ \frac{dP}{dt} = \beta e^{-\tau\omega}(\alpha N'P') - \alpha NP - \omega P, \]
\[ \frac{dR}{dt} = R\psi_R C/(K_R + C) - \omega R, \]

Use Levin's time delay model to study dynamics of susceptible and resistant bacteria in presence of phages.
Evolution of virulence.

Virulence and Pathogenesis of HIV-1 Infection: An Evolutionary Perspective

Christophe Fraser, Katrina Lythgoe, Gabriel E. Leventhal, George Shirreff, T. Déirdre Hollingsworth, Samuel Alizon, Sebastian Bonhoeffer

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