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A Nonlinear ODE Model of Butyrate-Tumour-Immune Cell Dynamics in Colorectal Cancer

Colorectal cancer progression is strongly influenced by metabolic signals from the gut microbiome, yet the underlying mechanisms remain poorly understood. In particular, the short-chain fatty acid butyrate - produced by fiber-fermenting gut bacteria - has been shown to inhibit cancer cell proliferation while supporting the growth and function of healthy colonocytes and immune cells. We formulate a system of non-linear ordinary differential equations to describe key metabolic and immunological interactions between butyrate, colorectal cancer cells and host cell populations. The parameter space is explored through steady-state and sensitivity analyses, and preliminary simulations illustrate the emergence of varying dynamical behaviour driven by butyrate availability.