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A metabolic-consumer-resource model with a moving tumour boundary

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In this study, we consider a spatial consumer-resource model with linear diffusions, where the tumour cells are assumed to consume oxygen and experience oxidative metabolism. By adopting an oxygen-dependent metabolic rate in this reaction-diffusion model, we demonstrated in our previous study that the model was capable of simulating spheroids grown in both normoxia and hypoxia. However, the model considers a fixed calculation domain, which limits its consumer-resource interaction and tumour growth to within that domain. Furthermore, the tumour's outer boundary is determined solely based on a low value of the tumour cell density, which causes difficulty when the density is not a monotonic function with respect to the distance from the spheroid center. Here, the metabolic-consumer-resource tumour model is modified to explicitly account for the moving tumour's outer boundary, allowing the tumour to expand or shrink due to the variations in oxygen supply including during deoxygenation and reoxygenation.

Keywords: solid tumour, tumour spheroids, metabolism, reaction-diffusion, deoxygenation, reoxygenation, hypoxia

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