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Modelling the Spatio-Temporal Distribution of Drugs in Tumours

The distribution of drugs in tumours is studied in a multiscale modelling framework. On the molecular scale we analyse the random walk of drug molecules through subsystems of the vascular network, from which molecules extravasate into the tissue, diffuse in the interstitial space, bind to receptors on the surfaces of tumour cells and finally induce apoptosis. Knowledge gained on the molecular scale, like diffusion coefficients and reaction rates, is then incorporated in a multiscale model of vascular tumour growth and angiogenesis. The model combines blood flow, angiogenesis, vascular remodelling, interactions between normal and tumour cells and diffusive nutrient / VEGF transport as well as cell-cycle dynamics within each cell. To study the effects of therapies, the model enables us to include a drug specific intracellular response (modelled by ordinary differential equations) and link it to an extracellular drug concentration that is described by reaction-diffusion equations. Drugs are supplied by the vascular system and adsorbed by normal and cancer cells, as well as decomposed by natural decay.

The numerical simulations let us analyse how the heterogeneity of the tumour structure influences the drug distribution and lead to predictions of therapeutic efficacy.