A computational framework for multi-scale vascular tumour growth models.

J.A. Grogan, A.J. Connor, J.M. Pitt-Francis, P.K. Maini, H.M. Byrne

Multi-scale models of vascular tumour growth are usually comprised of several interacting sub-models, which include the effects of blood flow, cell cycling, nutrient transport and angiogenesis. There are many ways to formulate the sub-models, incorporating different biophysical details. It is of interest to determine how overall predictions of vascular tumour growth depend on the choice and combination of sub-models. To perform such an investigation, it is necessary to design models and software that allow the overall vascular tumour growth model to be constructed in a flexible, modular fashion.

Here, a new framework for modelling vascular tumour growth is presented, based on the Chaste (Cancer, Heart and Soft Tissue Environment) open source software library. Through the use of Chaste, it is possible to construct models in a modular fashion and easily interchange sub-models. The new framework allows for three dimensional on- and off-lattice modelling of tumour growth and angiogenesis, incorporates models of blood flow, haematocrit transport and structural adaptation and includes tools for the construction and analysis of vessel networks and complex tissue domains.

Some applications of the framework, including predictions of blood flow and oxygen transport in realistic vascular tumour micro-vessel geometries and a comparison of tumour growth modelling approaches for vascularized tumour spheroid and corneal micro-pocket assay applications, will be demonstrated.