Fine- grained simulation of the microenvironment of vascularized tumors

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One of many important features of the tumor microenvironment is that it is a place of active Darwinian selection where different tumor clones become adapted to the variety of ecological niches that make up the microenvironment. These evolutionary processes turn the microenvironment into a powerful source of tumor heterogeneity and contribute to the development of drug resistance in cancer. We developed a computational tool to study the ecology of the microenvironment by combining a lattice-free simulation of tumor cells (VBL) with a lattice based blood vessel dynamic simulation (Tumorcode) to mimic vascularized solid tumors at the tissue scale. The simulation of the partial oxygen pressure (P_{O2}) and the pH in a virtual setup, similar to the experimental setup used by Jain et al., produced remarkably similar data. In addition to the experimental setup, our approach allows a time resolved study of the tumor microenvironment at the angiogenetic switch. We observed the formation of ecological niches at a very early stage of tumor growth and conjecture that the high evolutionary pressure (Darwinian dynamics) is one reason for tumor heterogeneity.