Project abstract

Blood circulation is essential to many physiological processes, ranging from embryonic development, tissue growth, differentiation, homeostasis and repair as well as for many pathological conditions such as inflammation, atherosclerosis and cancer. Blood vessels characteristics and features of blood flow are intimately interconnected. Two extreme conditions of blood flow can be differentiated: laminar and turbulent flow. While laminar flow is the physiological condition in most vessels, turbulent flow appears under situations of abnormal vascular architecture, flow or pressure. Endothelial cells can sense laminar and turbulent flow: laminar flow induces endothelial cell quiescence, is atheroprotective and anti-inflammatory, while turbulent flow causes endothelial cell activation, and is atherogenic and pro-inflammatory. Malignant tumors induce the formation of tumor-associated vessels that supply the growing tumor with nutrients, remove metabolic byproducts and they favor tumor cell escape to distant tissues. Tumor vessels are different from the vasculature of normal tissues in many respects. They are chaotic, irregular and heterogenously perfused. The exact flow conditions inside tumor vessels and the possible impact on delivery of nutrient and therapeutic drugs to the tumor are only partially characterized. Mathematical modeling of perturbed blood flow as it occurs in tumor vessels can be used to estimate the consequences on tumor biology and drug delivery and to propose models and hypotheses to be tested experimentally. Modeling of such biological phenomena, however, is still a huge issue, which has to be addressed through mathematical and algorithmic approaches and validated by experimental approaches.