Project: Cancer, nano-particles tracking, 3D printing and machine learning

Cancer is characterized by profound changes in the surrounding vasculature because the cancerous tissue is more energy demanding than normal tissue. As such the vasculature is multiplied in a chaotic, leaky network in the surroundings of a tumor, the so-called enhanced permeability and retention (EPR, see Fig. 1) effect. In detail, the vessels are formed by poorly aligned endothelial cells with wide fenestrations (100–500 nm compared to 10 nm in healthy tissue and in lack of smooth muscle cells. To take advantage of this poorly structured leaky vessels that surround the tumor for drug delivery, anti cancer nano-particles (NP) (between 10 and 500-100nm) have been proposed as carriers of drugs. Theoretically, the particles of diameter more than 10 nm

Figure 1: Illustration of the nano-particle flow in a tumor represented as a porous media coupled to the viscous blood flow.

Figure 2: Image of zebrafish model for cancer. White arrowheads show the normal almost linear intersegmental vessels while the blue arrowheads indicate the chaotic organisation due to angiogenesis at the tumour site (vessels partly yellow). Bottom left-bright field- tumour shows a visible bump due to tumour growth. Bottom right shows only the vasculature. Scalebar 100μm.
would only escape the blood stream through the enlarged fenestrations of the tumor tissue, leaving healthy tissue. However, typical deliverance of administered dose of NP to tumors typically is less than 5%.

To gain insight in the microcirculation of cancerous tissue, our partners at IBV have developed a zebrafish model of cancer in which the detailed flow can be studied with great resolution, see Fig 2. The subject of this project will be to develop algorithms to track the nano-particles. We begin in 3D printed geometries of vessels before we test the tracking in data obtained from zebrafish. Machine learning as well as more traditional techniques will be tested.

You will learn: Methods for particle tracking, machine learning, lab work, simulation

Prerequisites: A background in mechanics and experimental work.

Contact: Kent-Andre Mardal (kent-and@math.uio.no)

Associates: Gareth Griffiths, Federico Fenaroli