Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Modeling of Nutrient Transport and the Onset of Hypoxia in a Microfluidic Cell Culture Environment[1] ADNAN MORSHED, PRASHANTA DUTTA, Washington State University — Transport of essential nutrients such as oxygen and ascorbate plays a critical role in dictating tumor growth. For example, hypoxia, the depletion of intracellular oxygen levels below 6%, initiates major changes in cellular dynamics causing tumor cell survival. The intercapillary distance (distance between blood vessels) across a colony of growing tumor cells and the flow around the colony are important factors for the initiation of hypoxia. In this study, the dynamics of intracellular species inside a colony of tumor cells are investigated by varying the flow and unsteady permeation in a microfluidic cell culture device. The oxygen transport across the cell membrane is modeled through diffusion, while ascorbate transport from plasma is addressed by a concentration dependent uptake model. Our model shows that the onset of hypoxia is possible in HeLa cell within the first minute of total extracellular oxygen deprivation. This eventually leads to anoxia inside the cell block representing the development of a necrotic core that maintains a dynamic balance with growing cells and scarce supply. Results also indicate that the intercapillary distance and flow rate of nutrients can alter this balance, which has implications in the progression of hypoxic response.

[1]This work was supported in part by the U.S. National Science Foundation under grant no. DMS 1317671.

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Date submitted: 01 Aug 2016 Electronic form version 1.4