OSTI Phase 1: A Cellular Automaton Model of Early Tumor Growth and Invasion: The Effects of Native Tissue Vascularity and Increased Anaerobic Tumor Metabolism by A.A. Patel et al.

Introduction

Tumour growth can be classified into a few distinct stages, which are hyperplasia, dysplasia, in situ carcinoma and finally invasive cancer. As tumours are made up of rapidly dividing cells, they require high amounts of oxygen and glucose for survival and cell division. This rapidly overwhelms the ability of normal blood vessels to provide these nutrients and leads to angiogenesis within the tumours as well as the death of both normal cells as well as cells in the interior of the tumour. Also, as a consequence of hypoxia within the tumour, cells switch to using anaerobic respiration and release lactic acid into the extracellular environment. This causes a decrease in the pH in the environment within and around the tumour and also leads to necrosis.

Cellular automata has a long history of usage to model the growth and development of tumours. In this investigation by A.A. Patel et al, a hybrid cellular automaton was used to model an early stage of tumour growth. The cellular automaton assumes tumour avascularity and a random distribution of blood vessels in a tissue, which is true for pre-angiogenic tumours. The model includes variables for glucose and lactic acid concentration. It however, does not include a variable for oxygen concentration as the author is focusing on the effects of acidification of the microenvironment rather than hypoxia. It was shown[1] that anaerobic respiration in tumour cells persists even in high levels of oxygen and tumour cell viability is independent of oxygen levels[2].