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# The Role of Cell-Cell and Cell-Matrix Adhesion in Cancer Cell Invasion: A Multiscale Individual-Based Modelling Approach

The malignancy of almost all types of solid tumours is determined by the ability of cancer cells to invade the surrounding tissues and then to form secondary tumours (metastases) at distant sites in the body. These metastases are responsible for 90% of cancer deaths. In order to advance and improve cancer treatment strategies, it is therefore of high importance to understand the processes involved in cancer cell invasion.We focus on modelling the first steps driving localised cancer cell invasion and try to identify key processes that lead to observed invasion patterns and that allow collective cell migration and/or the detachment of individual cells or small cell clusters from the main tumour mass.

In order to do this, we use an individual-based, force-based multi-scale approach and model the physical properties of the cells and intra- and inter-cellular protein pathways involved in tumour growth, cell-cell and cell-matrix adhesion. The key pathways include those of E-cadherin and beta-catenin. Our approach also allows us to model the components of the extracellular matrix explicitly (e.g. fibronectin fibres).

Using computational simulations, we consider a growing mass of cells and investigate the spatio-temporal distribution of E-cadherin and beta-catenin levels in individual cancer cells and predict what implications this has for the adhesion of the cancer cells to each other and to the extracellular matrix. By examining the cell-matrix interactions with our model we can furthermore highlight the importance of the microenvironment in tumour progression and how the composition of the matrix together with the E-cadherin/beta-catenin dynamics may lead to different invasion patterns. We also show the influence of matrix realignment caused by cell traction forces on the cells' invasive behaviour and the spatio-temporal patterns that emerge.