The Mechanics and Forces Affecting Collective Cell Migration

Netanya Alwis and Christiana Routsi

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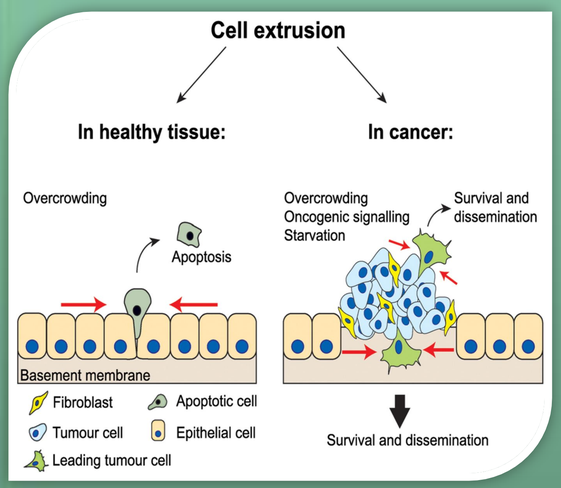
Introduction:

The ability of cells to interact, migrate and coordinate with each other is crucial for the development of multicellular organisms. Collective cell migration is particularly important during morphogenesis, regeneration and wound healing. Furthermore, in adult tissues, the dysfunction of cell adhesion can lead to the development of tumours. So further clarifying the mechanisms underlying collective cell migration is essential for the development of new therapies that prevent tumours spreading.

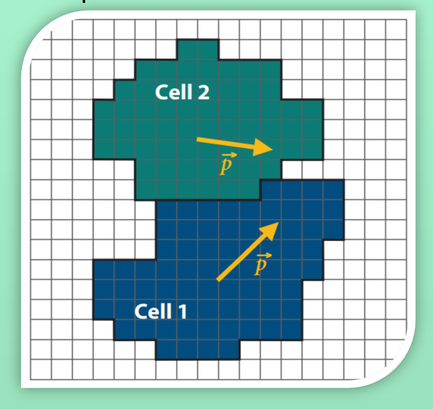
Cancer Cell and Tumour Cell Migration:

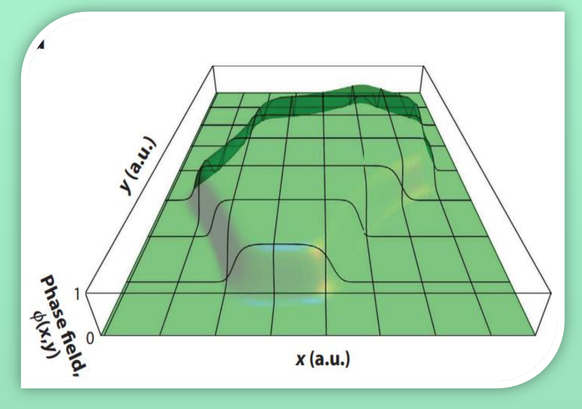
Cell migration is a key central process that is involved in the development of multicellular organisms, particularly in embryonic development. Cell migration is a relatively new topic that has a variety of different thoughts: some believe that cells are moved by pressure whether it being preexisitng or generated in processes such as cell division. Others propose that traction forces exist that are carried out by leader cells that propel the cluster of cells forward.

Cell migration is evident during tumour formation when the cancer cells migrate chemotactically driven by the activity of the cell membrane and its attachment to the extracellular matrix. New experiments have provided scientisits with a new insight and approach to understanding the mechanisms of how cancer cell migration is regulated by its microenvironment. This, coupled with the in vitro studies have consequently led to the undertsanding of chemotactic migration during cancer cell metastatis. Below, the diagram shows how stressful environments can lead to cancer cells forming and the photograph on the right shows cancer cell migration on elongate protrusion of fibroblasts in collagen matrix.



Multiple physical models have been developed to represent collective cell migration, here we focus on two-dimensional representations :





- ***Left:*** **The Cellular Potts Model** : this model describes individual cells as domains on a lattice, which helps determine subcellular details of cell shape. It allows for a close analysis of mechanisms of cell arrangements. However, the model cannot distinguish between cell-cell and cell-substrate friction.

- ***Right:*** **Phase Field Model** : This model depicts each cell as a phase field, which provides a detailed description of the cell shape. It is currently better linked with tissue mechanics, providing an explicit account for cell-cell and cell-substrate friction

- Active Network Models describe epithelial tissues as networks of polygonal cells, making it suited to studying the role of cell geometry on cell motion.

Conclusions And Discussion:

Cell migration and the mechanics behind cell movement is becoming an increasingly important subject of research. Cell migration is evidently a multidisciplinary field that incorporates nanotechnology, cell biology and cell mechanics. This field of science has led to medical advancements such as: cancer cell mechanics and implantable technologies. A better understanding of the mechanics that define the migration of two cells upon contact is central to advancing our understanding of collective cell migration and cancer cell mechanics. Furthermore, generalising 2D models and theories to 3D is yet another challenges of cell migration biophysics.

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