Research Summary

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1 Extracellular Matrix (ECM)

For an extensive overview, see [1].

- The ECM constitutes the non-cellular parts of all tissues.
- It consists of:
  - Fibrous proteins, most importantly collagen, elastin and fibronectin.
  - Up to 30% collagen. Forms fibrils and fibers of different sizes which can "stick together" to make up networks. There are a bunch of different collagen types.
  - Proteoglycans, which fill the interstitial space in the form of a hydrated gel.
- Cells move through and remodel their ECM, which in turn changes their behavior.
  $\Longrightarrow$ *in silico* models need to take this into account.
- Different tissues have different ECMs.

1.1 Properties of the Extracellular Matrix

Our approach takes a macroscopic view of the ECM. Individual fibrils/fibers should not be modeled. Nevertheless we include some microscopic properties.

- **Density**
- **Stiffness**: Matrix stiffness has an effect on tumor gowth, e.g. [2]. Measured using Young's modulus/elastic modulus which is given in Pa.
- **Viscoelasticity**
- **Pore size**

[1] mentions Matrigel™ and collagen type I gels, so we will focus on these.

2 Cellular Potts Model (CPM)

- The CPM is a grid-based Monte-Carlo simulation for cells.
- Each cell consists of many voxels. These voxels contain its cell ID.
- In each Monte-Carlo Step (MCS), a random voxel copies the cell ID of its neighbor.
- The hamiltonian H gives the energy of a generation. It depends on the volume and surface of cells and their reciprocal adhesion.
- A MCS is always accepted if it reduces H. If it does not reduce H, it is accepted probabilistically.

3 NAStJA & CiS

- Neoteric Autonomous Stencil code for Jolly Algorithms (NAStJA) is a massively parallel stencil code solver based on OpenMPI.
- Cells in Silico (CiS) is an implementation of the CPM in NAStJA.

4 The ECM in the CPM

5 Glossary

Acronyms

CiS Cells in Silico. 2

CPM Cellular Potts Model. 2

ECM Extracellular Matrix. 1, 2

MCS Monte-Carlo Step. 2

NAStJA Neoteric Autonomous Stencil code for Jolly Algorithms. 2

References

[1] Christian Frantz, Kathleen M. Stewart, and Valerie M. Weaver. The extracellular matrix at a glance, 12 2010.

[2] Kandice R. Levental, Hongmei Yu, Laura Kass, Johnathon N. Lakins, Mikala Egeblad, Janine T. Erler, Sheri F.T. Fong, Katalin Csiszar, Amato Giaccia, Wolfgang Weninger, Mitsuo Yamauchi, David L. Gasser, and Valerie M. Weaver. Matrix crosslinking forces tumor progression by enhancing integrin signaling. *Cell*, 139:891–906, 11 2009.