How nucleus mechanics and ECM topology influence the invasion of single cells and multicellular aggregates

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Abstract

In order to move in the network of fibers forming the extracellular matrix, the nucleus of a cell need to squeeze through the narrow spacing among the fibers and adhering to the extracellular matrix the cell need to exert strong enough traction forces. If the nucleus is too stiff, the spacing too narrow, or traction forces too weak, the cell in not able to penetrate the network. In this talk I will discuss several mathematical models to explore when cells can pass through a regular network of fibers and the qualitative behavior of the velocity as a function of the mechanical and topological characteristics of the network of ibers. For instane, treating the nucleus as an elastic body covered by an elastic membrane, one can find a necessary criterium involving quantities related to the traction forces exerted by the cells, the stiffness of the nuclear membrane and of the nucleus, and the ratio of the pore size within the extracellular matrix with respect to the nucleus diameter. The results obtained highlight the importance of the interplay between mechanical properties of the cell and microscopic geometric characteristics of the extracellular matrix.

References

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