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VERTEX AND PARTICLE-BASED METHODS FOR CELL AND TISSUE MECHANICS

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MINI-SYMPOSIUM PROPOSAL

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1 INTRODUCTION

Cell mechanical modelling at the tissue scale pose special challenges due to the inherent discrete nature of cells and the complex intra- and inter-cellular interactions. Vertex [1] and particle-based [10, 15] have become prominent modelling techniques due to their ability to describe cell boundary equilibria and remodelling aspects.

Early two-dimensional [6] and three-dimensional [7] vertex models have been enhanced with more sophisticated energy terms, biochemical coupling [13] and realistic geometrical descriptions [4]. This has allowed biologists not only understand the underlying mechanisms, but also predict and test scenarios in diverse applications. Just to cite a few, we mention cell division or apoptosis [12], cell remodelling [3], jamming [2], dome formation [9], or pattern [5], or larger scale phenomena such as wound healing [16, 8], organogenesis or morphogenesis [14, 11].

2 EXPECTED TOPICS

The proposed mini-symposia aims at gathering recent developments in vertex and particle-based methods. We are interested in new numerical techniques to handle complex cell-cell interaction and also in relevant biological applications.

More specifically, we expect contributions focused on:

- Cell and tissue discretisation techniques.
- Data-driven modelling and machine learning methods.
- Numerical modelling of cell-division or apoptosis.
- Cell reorganisation, intercalation and extrusion.
- Biochemical coupling and pattern formation.
- Stability and oscillatory behaviour.

Also, particular applications that exploit the numerical welcome are also welcome:

- Organogenesis and morphogenesis.
- Wound healing, zipping and invagination.
- Lumen formation and tubulation.

REFERENCES

[1] S. Alt, P. Ganguly, and G. Salbreux. *Philos. Trans. R. Soc. London B*, 372:20150520, 2017. http://dx.doi.org/10.1098/rstb.2015.0520.

[2] D. Bi, X. Yang, M. C. Marchetti, and M. L. Manning. *Phys. Rev. X*, 6:021011, 2016.

[3] K.E. Cavanaugh, M.F. Staddon, E. Munro, S. Banerjee, and M.L. Gardel. endocytosis. *Dev. Cell*, 52(2):152–166, 2020.

[4] P. Gómez-Gálvez, P. Vicente-Munuera, A. Tagua et al.epithelia. *Nat. Commun.*, 9(2960):1, 2018.

[5] S. Henkes, K. Kostanjevec, J. M. Collinson, R. Sknepnek, and E. Bertin. *Nat. Commun.*, 11(1405), 2020.

[6] H. Honda, M. Tanemura, and T. Nagai. *Int. Rev. Cytol.*, 1983(81):191–248, 1983.

[7] H. Honda, M. Tanemura, and T. Nagai. *J. Theor. Biol.*, 226:439–453, 2004.

[8] F. Ioannou, M.A. Dawi, R.J. Tetley, Y. Mao, and J.J. Muñoz. *Front. Bioeng. Biotechnol.*, 10:1–11, 2020.

[9] E. Latorre, S. Kale, L. Casares, et al. *Nature* 563(7730):203–208, 2018.

[10] G.R. Mirams, C.J. Arthurs, M.O. Bernabeu et al.*PLOS Comp. Biol.*, 9(3):e1002970, 2013.

[11] M. Misra, B. Audoly, I.G. Kevrekidis, and S.Y. Shvartsman. *Bioph. J.*, 110(7):1670–1678, 4 2016.

[12] S. Okuda, Y. Inoue, M. Eiraku, T. Adachi, and Y. Sasai. *Biomech. Model. Mechanobiol.*, 15(4):805–816, 2015.

[13] S. Okuda, T. Miura, Y. Inoue, T. Adachi, and M. Eiraku. *Sc. Rep.*, 8:2386, 2018.

[14] M.C. Perrone, J.H. Veldhuis, and G.W. Brodland. *Biomech. Model. Mechanobiol.*, 15(2):405–418, 2016.

[15] B. Smeets, M. Cuvelier J. Pešek, and H. Ramon. *Bioph. J.*, 116(5):930–937, 2019.

[16] M.F. Staddon, D. Bi, A. P. Tabatabai et al. *PLOS Comp. Biol.*, 14(10):e1006502, 2018.