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Mechanics and Anastomoses in Angiogenesis

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Angiogenesis - the growth of new blood vessels from a pre-existing vasculature - is key in both physiological processes and on several pathological scenarios such as cancer progression or diabetic retinopathy. We introduce a mathematical model that takes into account the role of mechanics in driving angiogenesis. The largest region in parameter space with well-formed long and straight sprouts is obtained when the proliferation is triggered by endothelial cell strain and its rate grows with angiogenic factor concentration. We conclude that in this scenario the tip cell has the role of creating a tension in the cells that follow its lead regulating endothelial cell proliferation and migration. For the new vascular networks to be functional, it is required that the growing sprouts merge either with an existing functional mature vessel or with another growing sprout. This process is called anastomosis. We present a systematic 2D and 3D study of vessel growth in a tissue to address the capability of angiogenic factor gradients to drive anastomose formation. We will demonstrate that the production of angiogenic factors by hypoxic cells is able to promote vessel anastomoses events in both 2D and 3D. We also verify that the morphology of these networks has an increased resilience toward variations in the endothelial cell's proliferation and chemotactic response.

REFERENCES

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