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From Individual Cells To Complex Tissues – an Immersed Boundary Approach

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We present a computational technique which can be applied in modeling development of complex tissues composed of various types of cells. This method allows us to treat cells as individual entities, with their own elastic plasma membrane, fluid cytoplasm, point nucleus and partial cytoskeleton, but also enables formation of cell clusters or cell sheets that act together as one complex tissue. The cell model includes membrane receptors used to sense signals from the surrounding microenvironment and based on these signals the cells can undergo different processes, such as growth, proliferation, apoptosis or chemotaxic migration. This model is based on the immersed boundary method and couples the dynamics of separate elastic cells with continuous description of a viscous incompressible cytoplasm. Applications include several computer simulations, such as formation of an early carcinoma or outgrowth of a capillary sprout in the early angiogenesis.

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