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Cell-based modeling of plant tissues using VirtualLeaf

Plant organs, including leaves and roots, develop by means of a complicated, multi-level cross-talk between gene regulation, patterned cell division and cell expansion, and tissue mechanics. In contrast to the cells in many animal tissues, plant cells cannot migrate and, with very few exceptions, they cannot slide past each other. Consequently, plant morphogenesis depends entirely on patterned cell division, cell expansion, and cell differentiation. Thus plant development requires different cell-centered models than those developed for animal development, in which cell migration and tissue folding play a primary role. We will present a cell-centered computer-modeling framework for plant tissue morphogenesis that we named *VirtualLeaf* [1]. We will illustrate the current use of VirtualLeaf with examples of auxin-driven vasculature development, determination of leaf shape, and meristem growth. VirtualLeaf defines a set of biologically intuitive C++ objects, including cells, cell walls, and diffusing and reacting chemicals, that provide useful abstractions for building biological simulations of developmental processes. VirtualLeaf-based models provide a means for plant researchers to analyze the function of developmental genes in the context of the biophysics of growth and patterning. VirtualLeaf is an ongoing open-source software project (http://virtualleaf.googlecode.com) that runs on Windows, Mac, and Linux.

References

[1] R. M. H. Merks, M. Guravage, D. Inzé, G.T.S. Beemster. *VirtualLeaf: an Open Source framework for cell-based modeling of plant tissue growth and development* Plant Physiology **155** 656–666, 2011.