The “Rooty Tooty Funny Fruities” present:

“An Agent-Based Model of Plant Cells to Investigate Lateral Root Development”

By Jan Hurt, Ravi Ranjan, and Helen Scott\*

\*Corresponding author: Helen Scott ([hscott@bu.edu](mailto:hscott@bu.edu))

Lateral root development serves as an excellent model system for studying plant organogenesis due to its well-defined stages and cellular processes. A central challenge in studying lateral root development is to understand how mechanisms at one level of biological scale (i.e., cell-level) interact to produce higher-level (i.e., tissue-level) phenomena. In the root, the plant maintains a supply of quiescent stem cells – stem cells which can be converted into actively dividing stem cells when needed. The stem cells undergo asymmetric cell division, resulting in a large semi-differentiated cell and a smaller stem cell which continues to grow and divide. Under gradients of plant hormones such as auxin and cytokinin, the semi-differentiated cells enter another phase known as endoreduplication where they synthesize multiple copies of their genome without dividing. The interconversion of these cell types results in a gradient of cell types in the root tissue, from actively dividing stem cells at the growing tip to elongated, differentiated cells at the end. While these processes have been characterized biochemically, they have primarily been studied at the cellular level and their interaction to generate root tissue has not been investigated. In this project, we plan to use agent-based models to understand how the cellular processes play out in a spatial setting to result in a well-organized tissue.

Agent-based modeling (ABM) is a computational technique that can be used to model collections of individual biological cells and compute their interactions, which generate emergent tissue-level results. While ABMs of bacterial or animal cells have been developed, in plant science ABMs have predominantly operated at larger scales, where agents represent individual plants or plant building blocks (aka metamers). Here we present the core of an agent-based model of growing plant cells, which must follow different physical rules than bacterial or animal cells. Future work will develop this core further to incorporate various factors in lateral root formation such as hormonal regulation and explicit spatial structure.