San Diego State University

SDSU Mathematics Colloquium Distinguished Lecture Series

Combined multiscale mathematical modeling and experimental analysis suggests possible mechanism of shoot meristem maintenance in plants

Monday, March 7, 2022 4pm–5pm, GMCS 405

Departmental Tea at 3:30pm

SPEAKER: Professor Mark Alber

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ABSTRACT: Stem cell maintenance in multilayered shoot apical meristems (SAMs) of plants requires strict regulation of cell growth and division. Exactly how the complex milieu of chemical (WUSCHEL and cytokinin) and mechanical signals interact to determine cell division plane orientation and shape of the SAM is not well understood. By using a newly developed mathematical model, combined with experiments, three hypothesized mechanisms have been tested for the regulation of cell division plane orientation as well as of cell expansion in the deeper SAM cell layers. Simulations predict that in the apical cell layers, WUSCHEL and cytokinin regulate the direction of anisotropic cell expansion, and cells divide according to tensile stress. In the basal cell layers, simulations also show dual roles for WUSCHEL and cytokinin in regulating both cell division plane orientation and the direction of anisotropic expansion. This layer-specific mechanism maintains the experimentally observed shape and structure of the SAM as well as the distribution of WUSCHEL in the tissue. Moreover, by using a dynamical signaling model, an additional mechanism underlying robustness maintenance of WUSCHEL gradient through its negative regulator, has been identified. Sensitivity analysis and perturbation study were performed to show validity of the mechanism across different parameter ranges. Currently, a coupled computational framework is being developed by integrating sub models representing a dynamical signaling network and cell mechanics to explore how the WUSCHEL expression domain and the tissue structure are maintained throughout the growth.

BIO: Professor Mark Alber earned his Ph.D. in mathematics at the University of Pennsylvania under the direction of J. E. Marsden (UC Berkeley and Caltech). He held several positions at the University of Notre Dame including most recently Vincent J. Duncan Family Chair in Applied Mathematics. He is currently Distinguished Professor in the Department of Mathematics and Director of the Center for Quantitative Modeling in Biology, UC Riverside. Dr. Alber was elected a Fellow of the American Association for the Advancement of Science (AAAS) in 2011. He is currently a deputy editor of PLoS Computational Biology and member of editorial boards of Bulletin of Mathematical Biology and Biophysical Journal. His research interests include mathematical and computational multiscale modeling of blood clot formation, plants development and growth and epithelial tissue growth.