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Interplay of mechanical and biochemical signals in plant morphogenesis

The Shoot Apical Meristems (SAM) initiate growth of new aerial plant organs like the leaves and flowers. Formation of the new primordia on the surface of the meristem involves complicated mechanical and biochemical interactions, yet meristem is able to achieve amazing regularity in repeating the patterns of outgrowth of the new leaves and flowers for the whole lifetime of the plant. From the mechanical point of view this requires a precise regulation of the amount and direction of the cellular growth. The former is influenced by polarized transport of the plant hormone auxin, while the latter is related to the directionality of the microtubule array.

By using the combination of experiments and modeling we have provided evidence that microtubules respond to mechanical stress and contribute to a feedback loop encompassing physical forces, microtubule orientation, mechanical anisotropy and morphogenesis [1]. We have shown also that auxin transport regulation by PIN1 can be explained by the mechanism which uses the mechanical stresses in the cell walls to convey information about auxin concentration in the neighboring cells. We presented a model of such interactions which is capable of creating phyllotactic patterns and is consistent with experimental results of cell ablations [2]. These results suggest that the mechanical signals are not only passively influenced by auxin patterning, but also actively direct transport of auxin using mechanical stress as a common regulator of PIN1 localization and mechanical anisotropy contributing to the emergence of the phyllotactic patterns.

References

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