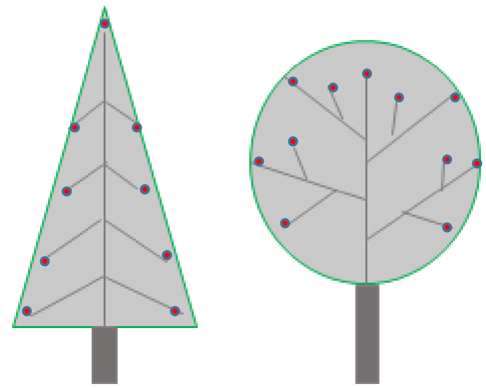
Master topics in Plant Cell & Developmental Biology

Interested in making discoveries in the area of plant development?

We try to solve yet unanswered fundamental questions in plant biology: how meristems function, how they interact with the environment and how their complex and species-specific architectural designs arise. We work at the genome, molecular and cellular level, using Arabidopsis and Populus, model plants with completely sequenced genomes. Populus is an important species that is cultivated globally for the production of lumber, paper, plywood as well as biomass. An important long-term goal is to find genes that regulate tree height, radial growth, xylogenic activity, as well as branch development.



Meristem cells at the tip of shoots are required for continuous axial growth. They also co-determine with axillary meristems the species-specific architectural design of a tree and its survival through winter.

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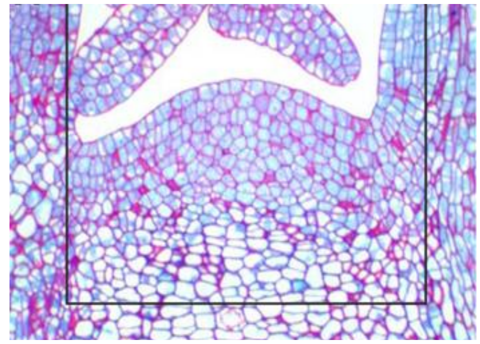
Unlike animals, higher plants have a unique potential to grow and develop throughout their life. This is because of the shoot apical meristem, a tiny field of semi-embryonic cells at the shoot apex, which is the ultimate origin of all other cells of the shoot. In some plants, this meristem can continue its embryogenetic activities even when it is hundreds of years old.

Meristems hugely influence biomass production because they initiate all leaves and the axillary buds that give rise to branches, thereby multiplying the number of stems. Given the correct signals, meristems have remarkable abilities to switch from shoot production to the production of flowers and fruits. Unique to deciduous perennials is their ability to cease meristem activity at the end of the growing season, establish dormancy, and continue the next season with building the trunk. Understanding meristem function is not only important scientifically, but also for developing strategies to increase yields, for example, through genetic modification of genes that regulate hormone biosynthesis and signalling.

At present, we are specifically interested in the novel 'branch-inhibiting hormone' strigolactone, its interaction with other hormones, and its regulation by transcription factors. A related area is that of lipid bodies, which accumulate in developing buds, and which function in dormant meristems that are exposed to the cold of winter. Underneath are two examples of possible projects in these areas (but master topics are not restricted to these).

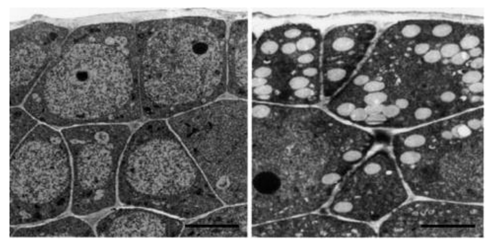
Example Master Topics:

How to branch out – control of axillary meristem activation. The axils of newly formed leaves contain cells that develop into an axial meristem that produces an axillary bud, which in turn can grow out into a branch. Although branching patterns have a genetic ground plan, there is a large variation within a species, the basis of which is not understood. This master topic explores the putative role of key plant hormones and the environmental control of AXB activation. Experiments involve controlled growth experiments, analysis of candidate gene expression, and at least one type of plant hormone analysis. Aim is to further the understanding of perennial branching.



Meristems can be in an inhibited (para-dormant or dormant) state, as well as in a morphogenetically active state. These states and the transitions between them remain incompletely understood.

Why plants are not obese – lipid bodies in plant meristem cells. The uncoupling protein (UCP1) functions in the mitochondrial inner membrane. It is well-known from human brown adipose tissue, where it generates heat through a non-shivering process of thermogenesis when a person is exposed to cold. UCP1 is also present in plant tissues, but it is unlikely to support non-shivering thermogenesis. This topic involves genome-wide identification of UCP1-like proteins in poplar, growth experiments and gene expression studies to understand the putative link between UCP1 and lipid body accumulation and its putative role in the overall cellular tolerance to stress.



Active meristem cells – no lipid bodies | Inactive meristem cells – many lipid bodies

Lipid bodies suddenly disappear at the onset of growth. How is this controlled?