FLOWERING
Is it blooming time yet?

PLANT LIFE CYCLE

Whether annual or perennial, the life cycle of a plant includes a reproductive stage, where flowers are formed. When timed correctly, flowering helps ensure reproductive success, and species survival: it is therefore not surprising that a complex molecular network exists to control the timing of flowering.

THE IMPORTANCE OF TIMING

Flowering is a prerequisite for fruit and grain production. Conversely, avoidance of flowering is necessary for harvesting vegetative parts of a plant (leaves, tubers, roots). The timing of flowering is therefore central to crop production management. Understanding the molecular network that controls flowering time can help breeders and farmers predict crop behaviour and plan production, as well as select and develop new crop species adapted to different climates. Until recently, most of the molecular research on flowering time has used Arabidopsis thaliana, an annual plant that flowers preferentially in long days conditions (i.e. spring time).

PHOTOPERIODISM: SENSING THE SEASONAL CHANGES

There is a selective advantage for flowering to happen during the adequate season, when conditions are the most favourable for reproduction (e.g. pollinators availability, warmer temperature).

How do plants sense seasonal changes? The duration of sunlight (photoperiod) is a good indicator of seasons. The ability to perceive photoperiod is due to the cooperation between plant photoreceptors and the circadian clock.

THE CIRCADIAN CLOCK

The circadian clock is the molecular network in most organisms that provides them with the innate ability to measure the time of the day. The circadian clock controls a large number of biological processes, giving them rhythms that follow an approximately 24h cycle. They allow organisms to not simply 'respond to' but rather 'anticipate' environmental cues.

Plant photoreceptors have a major role in re-setting the circadian clock daily, and contribute to the robustness of the clock outputs oscillations over time.

THE EXTERNAL COINCIDENCE MODEL

The molecular mechanism of flowering time in Arabidopsis involves the concomitant presence of clock-regulated and light-regulated elements.

A clock-regulated key protein, CO, is produced rhythmically at the same time everyday, throughout the year. In short days (autumn/winter), CO is produced when it’s dark. In long days (spring/summer), CO is produced when it’s day time: light-activated photoreceptors modify CO and render it capable of inducing the expression of a flowering gene. It’s time to flower!

A very similar model has been shown to regulate flowering time in rice, a short day plant. In this case however, light-activated CO inhibits the expression of the flowering gene: no flowering can happen as long as CO is produced in the day time. When CO is produced in the dark, the inhibition of the expression of the flowering gene is released, and the rice can flower.

FLOWERING can be triggered by the perception of short days (autumn) or long days (spring). Some species are day-neutral and flower throughout the year.