

# Plant Cell Biology

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We study self-incompatibility (SI), a genetic barrier that overcomes the negative consequences of inbreeding by stopping self-fertilisation from occurring. Although we refer to SI in the singular, in fact there are many different SI systems as SI has arisen repeatedly during the evolution of flowering plants. Self-fertilisation can happen when pollen is transferred within a flower (self-pollination) or between flowers on the same plant (geitonogamous pollination). Flowers of a self-incompatible plant are singularly remarkable in that they can distinguish the source of each of the thousands of pollen grains they receive so that only those pollen grains from another plant are allowed to fertilise the flower's precious cargo of ovules. Because SI prevents fertilisation following self and geitonogamous pollinations, self-incompatible plants are obligate outcrossers.

We study SI in the Solanaceae, a large family of flowering plants that includes plants such as the familiar petunia as well as tobacco and tomato. More recently we have begun to study SI in the Brassicaceae, of which cauliflower, radish and oilseed rape are well known examples.

SI in both families is controlled by a single genetic locus called the S locus. In the Solanaceae the S locus acts gametophytically whereas in the Brassicaceae it acts sporophytically. The figure shows how the S locus in gametophytic and sporophytic SI systems works to reject incompatible pollen.

There are a large number of S alleles at the S locus. Being diploid, each flower has two S alleles. In a gametophytic system, pollen grains express just the one S allele present in their haploid genome. In a sporophytic system, each pollen grain expresses the two S alleles present in the diploid sporophyte. Complex dominance interactions exist between sporophytic S alleles: an S allele can be either recessive to or co-dominant with another S allele. Regardless, a pollen grain that alights on flower expressing the same S allele is rejected. Only those pollen grains that express a different set of S alleles can fertilise an ovule.

From this simple biology, it is clear that the S locus must be expressed in both the pollen grain and pistil, which is the name given to the female reproductive tissues of the flower. To date, molecular studies on the Solanaceae system have shown that the pistil product of the S locus is a ribonuclease called the S-RNase – this enzyme has to be enzymatically active for pollen rejection to occur – and the pollen product is an F-box protein, a protein that selects other proteins for degradation by the ubiquitin pathway. How the S-RNase interacts with the F-box protein, how this interaction leads to the rejection of an incompatible pollen tube, and how new S allele specificities arise, are questions we are exploring using the tools of cellular and molecular biology.

In the Brassicaceae the pistil and pollen products of the S locus are a protein called SRK (for S locus receptor kinase) and a small, highly hydrophilic SRK ligand called SCR (S locus cysteine-rich protein) or SP11. We are studying this SI system in wild radish (*Raphanus raphanistrum*), a major weed that costs the Australian grains industry an estimated \$140 million each year in control costs and lost production. We aim to develop a molecule based on SCR/SP11 that non-specifically induces pollen rejection. Such a molecule would reduce seed production in wild radish and related cruciferous weeds without any of the toxicity issues of herbicides currently used to control these species.

## RECENT SELF-INCOMPATIBILITY PUBLICATIONS

Wheeler D & Newbigin E (2007) Expression of 10 S class *SLF-like* genes in *Nicotiana alata* pollen and its implications for understanding the pollen factor of the S locus. *Genetics* 177, 2171–2180.

Newbigin E, Hoebee S, Swain S, Groszmann, M & Young, A. (2006). Molecular control of reproduction in wild radish. *Proceedings of the Wild Radish and other Cruciferous Weeds Symposium*, 66-68.

Newbigin E & Uyenoyama MK (2005) The evolutionary dynamics of self-incompatibility systems. *Trends in Genetics* 21, 500-505.

Takebayashi N, Newbigin E & Uyenoyama M (2004) Maximum-likelihood estimation of rates of recombination within mating type regions. *Genetics* 167, 2097-2109.

Newbigin E and Vierstra R D (2003) Plant reproduction: Sex and self-denial. [Nature 423, 229-230.](#)

Takebayashi N, Brewer PB, Newbigin E and Uyenoyama MK (2003) Patterns of variation within self-incompatibility loci. [Molecular Biology and Evolution 20, 1778-1794.](#)

Uyenoyama MK, Zhang Y and Newbigin, E (2001) On the origin of self-incompatibility haplotypes: Transition through self-compatible intermediates. [Genetics 157, 1805-1817.](#)

MacIntosh GC, Bariola PA, Newbigin E and Green PJ (2001) Characterization of Rny1, the *Saccharomyces cerevisiae* member of the T 2 RNase family of RNases: Unexpected functions for ancient enzymes? [Proceedings of the National Academy of Sciences, USA 98, 1018-1023.](#)

Golz JF, Oh H-Y, Su V, Kusaba M, Newbigin, E (2001) Genetic analysis of *Nicotiana* pollen-part mutants is consistent with the presence of an S-ribonuclease inhibitor at the S locus. [Proceedings of the National Academy of Sciences, USA 98, 15372-15376.](#)

Newbigin, E and Uyenoyama MK (2000) Evolutionary dynamics of dual-specificity self-incompatibility alleles. [Plant Cell 12, 310-312.](#)

Li J-H, Nass N, Kusaba M, Dodds PN, Treloar N, Clarke AE and Newbigin E (2000) A genetic map of the *Nicotiana alata* S locus that includes three pollen-expressed genes. [Theoretical and Applied Genetics 100, 956-964.](#)

Golz JF, Clarke AE and Newbigin E (2000) Mutational approaches to the study of self-incompatibility: Revisiting the pollen-part mutants. [Annals of Botany 85, 95-103.](#)

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