Biologi Perkembangan (Tumbuhan)

Inkompotibilitas Seksual

Adi Rahmat
1. Jurusan Pendidikan Biologi, Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam, UPI
2. Program Studi Pendidikan IPA, Sekolah Pascasarjana, UPI

Self-Incompatibility: Avoiding Inbreeding

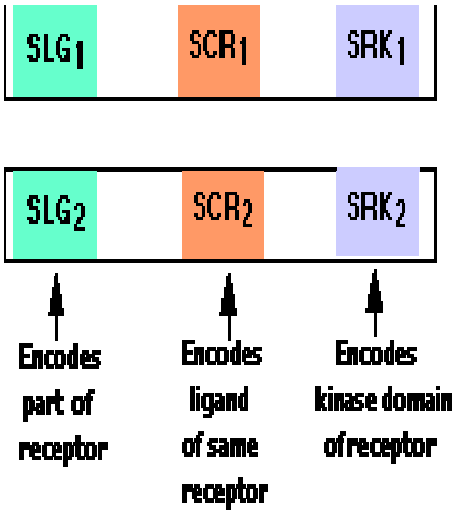
- Evolution seems to favor (and be favored by) genetic variability.
- Genetic variability is promoted by **outbreeding:** sexual reproduction between genetically dissimilar parents.

How do they avoid self-fertilization?

- **Heteromorphic flowers**.
  The flowers are perfect but come in two structural types; for example
  - long stamens with a short style and
  - short stamens with a long style.

- **Homomorphic flowers**.
  All flowers have exactly the same structure.
  Avoidance of self-fertilization depends on genetic/biochemical mechanisms. There are two quite different types of self-incompatibility.
  - **Sporophytic self-incompatibility** (SSI)
  - **Gametophytic self-incompatibility** (GSI)

Sporophytic Self-Incompatibility (SSI)



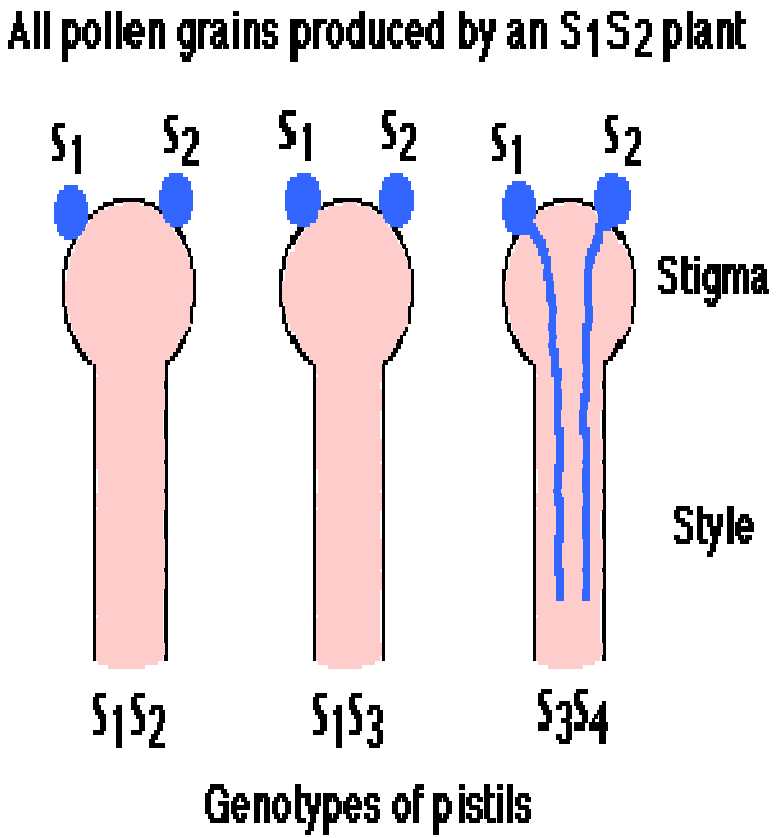
Structure of the S loci in the sporophyte of an S_1S_2 plant

- Rejection of self pollen is controlled by the diploid genotype of the sporophyte generation.
- The control lies in the "**S-locus**", which is actually a cluster of three tightly-linked loci:
  - ***SLG*** (**S**-**L**ocus **G**lycoprotein) which encodes part of a receptor present in the cell wall of the stigma;
  - ***SRK*** (**S**-**R**eceptor **K**inase), which encodes the other part of the receptor. Kinases attach phosphate groups to other proteins. SRK is transmembrane protein embedded in the plasma membrane of the stigma cell.
  - ***SCR*** (**S**-locus **C**ysteine-**R**ich protein), which encodes a soluble, **secreted ligand** for the **same** receptor.
- Because the plants cannot fertilize themselves, they tend to be heterozygous (here designated S_1 and S_2).
- Different S alleles may be present in the **population** of the species.
- The difference between the alleles is concentrated in certain "**hypervariable regions**" of the receptor (analogous to the hypervariable regions that provide the great binding diversity of **antibodies**.

Sporophytic Self-Incompatibility (SSI)

The rules:

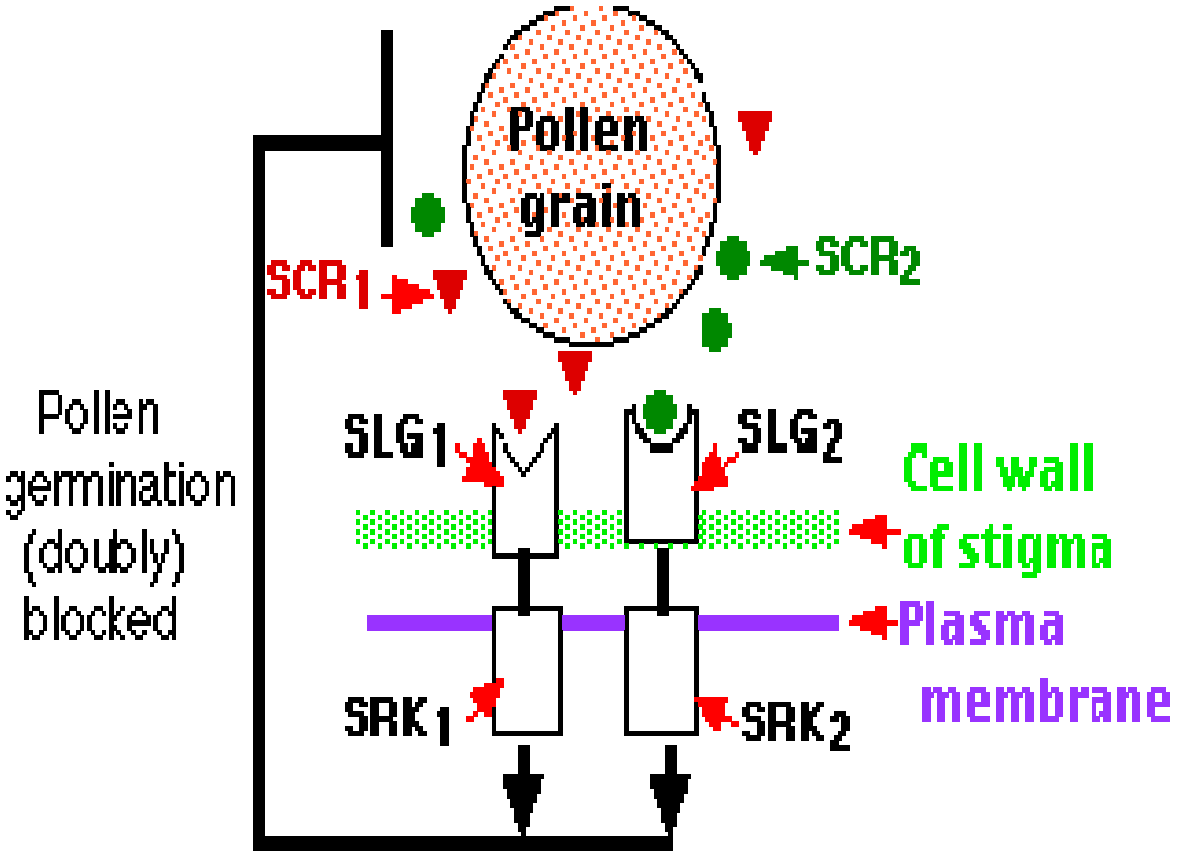
- Pollen will not germinate on the stigma (diploid) of a flower that contains **either** of the two alleles in the sporophyte parent that produced the pollen.
- This holds true even though each pollen grain — being haploid — contains only one of the alleles.
- In the example shown here, the S_2 pollen, which was produced by a S_1S_2 parent, cannot germinate on an S_1S_3 stigma.



Sporophytic Self-Incompatibility (SSI)

The explanation:

1. The S_1S_2 pollen-producing sporophyte synthesizes both SCR_1 and SCR_2 for incorporation in (and later release from) **both** S_1 and S_2 pollen grains.
2. If **either** SCR molecule can bind to **either** receptor on the pistil, the kinase triggers a series of events that lead to failure of the stigma to support germination of the pollen grain. 3. Among these events is the ubiquination of proteins targeting them for destruction in proteasomes.
3. If this path is not triggered (e.g., pollen from an S_1S_2 parent on an S_3S_4 stigma, the pollen germinates successfully.

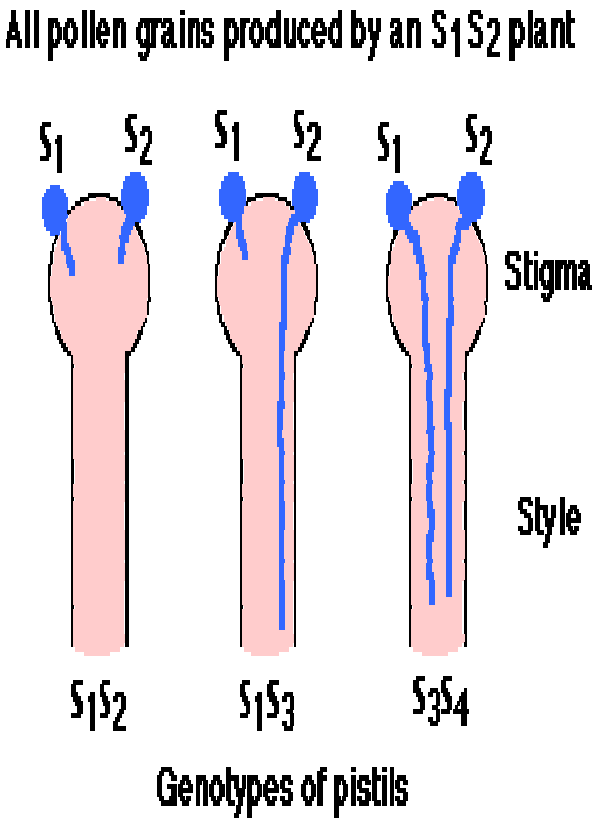


Gametophytic Self-Incompatibility (GSI)

This form of self-incompatibility is more common than SSI.
It occurs in nearly one-half of all the families of angiosperms, including

- the Solanaceae (potatoes, tomatoes [wild, not cultivated], and tobacco)
- beets (Beta vulgaris)
- buttercups (Ranunculus)
- lilies
- roses
- many grasses

Gametophytic Self-Incompatibility (GSI)



The rules:

- The S loci are (as in SSI plants) extremely polymorphic; that is, there is an abundance of multiple alleles in the population.
- Incompatibility is controlled by the single S allele in the haploid pollen grain.
- Thus a pollen grain will grow in any pistil that does not contain the same allele (so, as shown here and in contrast to what happens in SSI, S_2 pollen from an S_1S_2 parent will grow down an S_1S_3 style.

GSI mechanism in tobacco

- All pollen grains — incompatible as well as compatible — germinate forming pollen tubes that begin to grow down the style.
- However, growth of incompatible pollen tubes stops in the style while compatible tubes go on to fertilize the egg in the ovary.
- The block within incompatible pollen tubes is created by an S-locus-encoded **ribonuclease** (RNase), which is
  - synthesized within the **style**;
  - enters the pollen tube and
  - destroys its RNA molecules
  - halting pollen tube growth.