Self incompatibility

- self incompatibility refers to the inability of plant to set seed with functional pollen after self polllination.
- Koelreuter -1st reported S.I in *Verbascum phoeniceum* plants(18th century)
- Self incompatibility reported in about 70 family of angiosperm including several crop spp.
- It is importnant for outbreeding mechanism(cross pollintaion) for normal fruit set.
- It maintained high degree of heterozygosity and can take place any stage between pollination and fertilization.

History of self-incompatibility

- First discussion on self-incompatibility by Darwin (1877)
- The term self incompatibility was given by Stout (1917)
- Bateman (1952, 1954, 1955) gave explanation on incompatibility in three *Brassicas* plants namely, *Iberis amara* L., *Raphanus sativus* L. and *Brassica campestris* L.

Causes of S.I

- Self incompatible pollen grain may fail to germinate on the stigmatic surface.
- Some may germinate but fails to penetrate the stigmatic surface.
- Some pollen grains may produce pollen tube, which enters through stigmatic surface, but its growth will be too slow. By the time the pollen tube enters the ovule the flower will drop.
- Some time fertilziation is effected but embryo degenerates early.

Classification of self incompatibility

- According to Lewis (1954) the self incompatibility is classified as follow

Self incompatibility

Heteromorphic system   Homomorphic system

Distyl   Tristylty   Gametophytic S.I   Sporophytic S.I

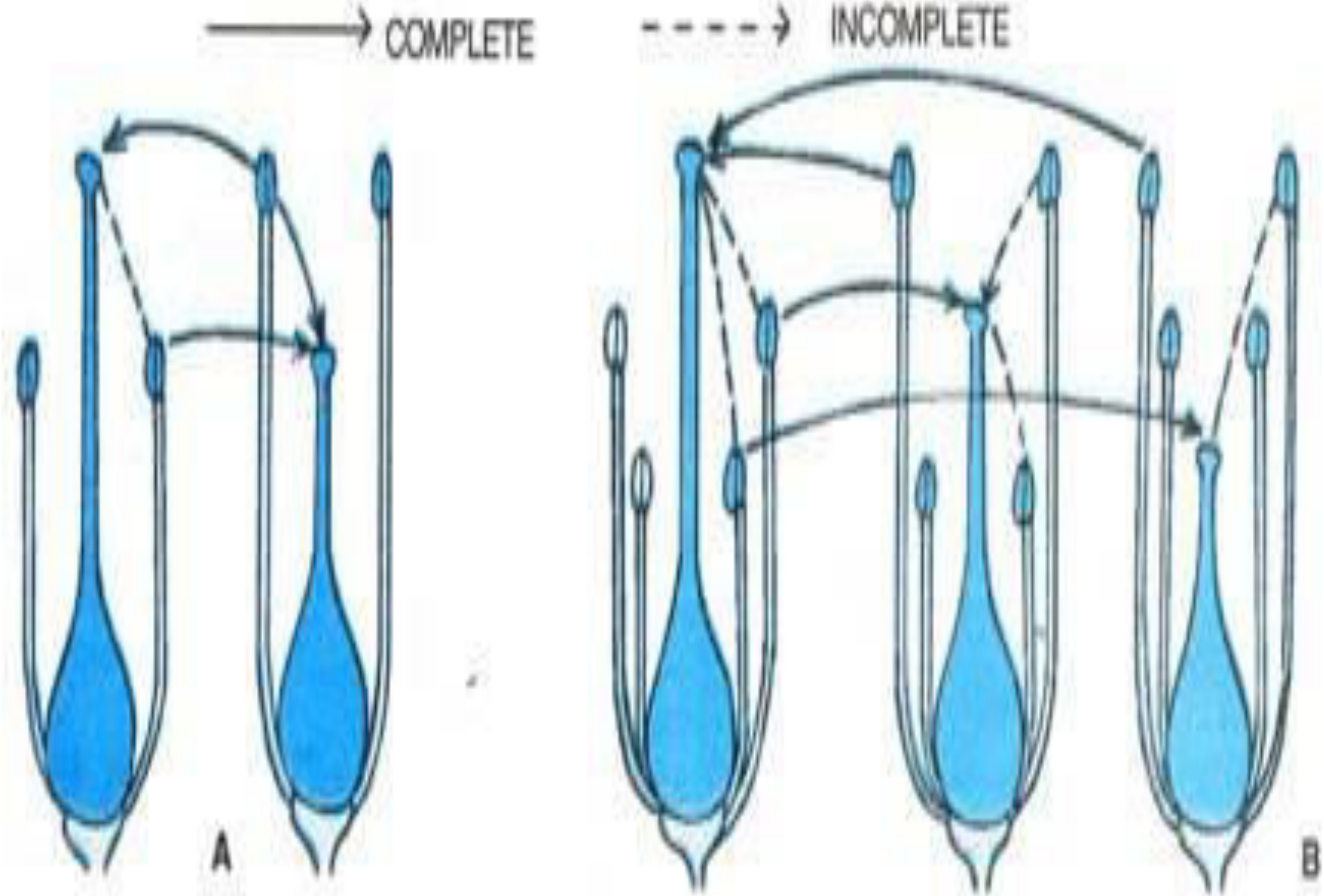


Fig. 2.37. Diagrammatic representation of heteromorphic incompatibility.

The most common anti-selfing mechanism in flowering plants is known as self-incompatibility, the ability of a plant to reject its own pollen.

Researchers are unraveling the molecular mechanisms that are involved in self-incompatibility

Genetics of self-incompatibility

- Bateman (1955) described the control of SI in family *Brassicaceae* by a single Mendelian locus, the S (Sterility) locus, which exists as multiple alleles

✓ The number of S-locus alleles is usually large:-

➢ 22 in Iberis (Bateman 1955)

➢ 34 in Raphanus (Sampson 1957)

➢ 30 in *B. rapa* (Nou *et al.* 1993)

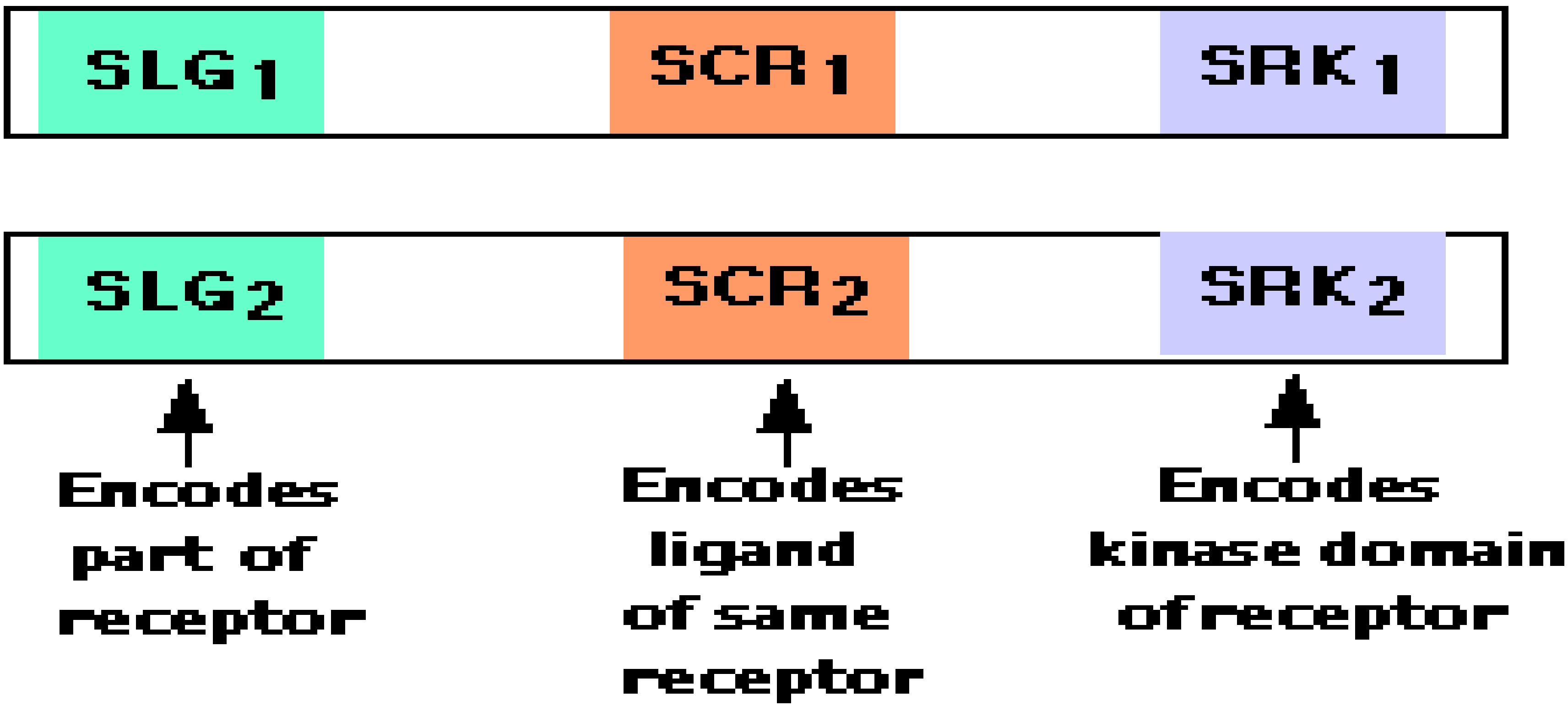
➢ 50 in *Brassica oleracea* (Brace *et al.* 1994)

In grasses SI is GSI but two unlinked loci
S & Z are required

Molecular basis of S- locus

- With classical genetics S-locus was assumed to be a single gene but after 1987 molecular studies revealed S-locus to be much more complex
- S-locus glycoprotein (SLG) gene which encodes a secreted glycosylated protein (Nasrallah *et. al.,* 1987)
- SRK gene which encodes a receptor protein at stigmatic surface (Steln *et al*,1991)
- S-locus cysteine rich protein (SCR) gene (Schopfer *et al* ,1999)
- expression of these genes are temporally (anthesis) and spatially (Stigma) regulated

S locus



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

1) Sporophytic Self-incompatibility (SSI):

In this case, self-incompatibility is governed by genotype of pollen producing plant i.e. diploid genotype of the sporophyte generation.

It is controlled by single gene S with multiple alleles, where alleles may show individual action, dominance or interaction in pollen or style.

S-locus is a cluster of three tightly-linked loci,

a) SLG (S-Locus Glycoprotein),
b) SRK (S-Receptor Kinase)
c) SCR (S-locus Cysteine-Rich protein)

SSI

This form of self-incompatibility has been studied intensively in members of the mustard family (**Brassica**), including turnips, rape, cabbage, broccoli, and cauliflower.

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; that is, carry a pair of different S loci (here designated S_1 and S_2).
- However, **dozens** of different S loci may be present in the **population** of the species; that is; the S-locus in the species contains multiple alleles ..
- 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** .

- 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.

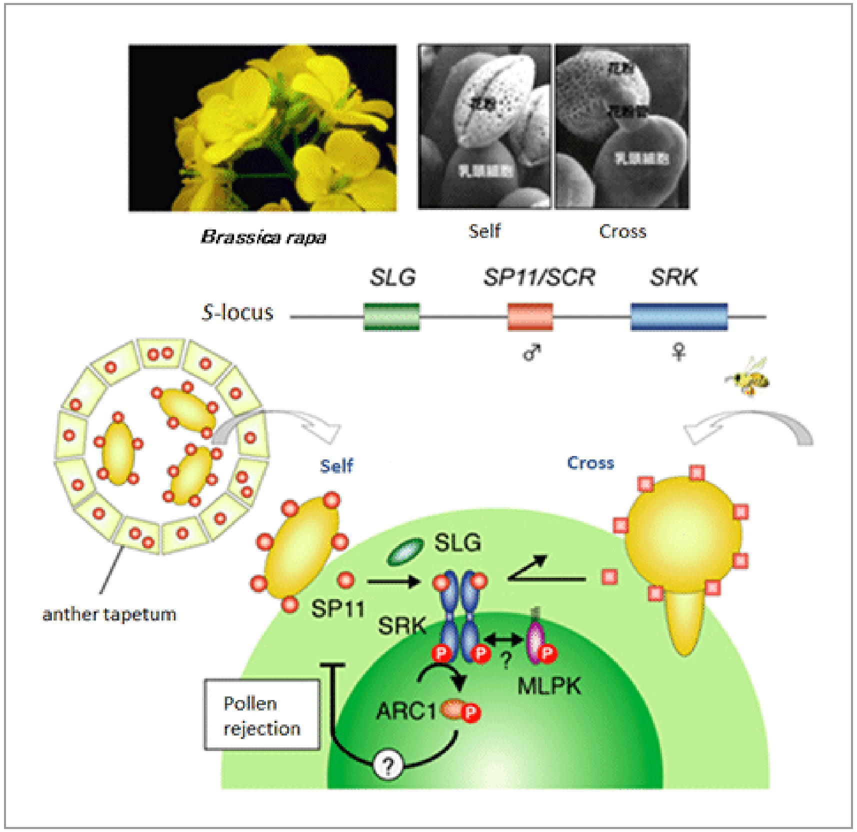
- The S_1S_2 pollen-producing sporophyte synthesizes both SCR_1 and SCR_2 for incorporation in (and later release from) **both** S_1 and S_2 pollen grains.
- If **either** SCR molecule can bind to **either** receptor on the pistil, the kinase triggers a series of events that lead to failure of the stigma to support germination of the pollen grain.
- 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.

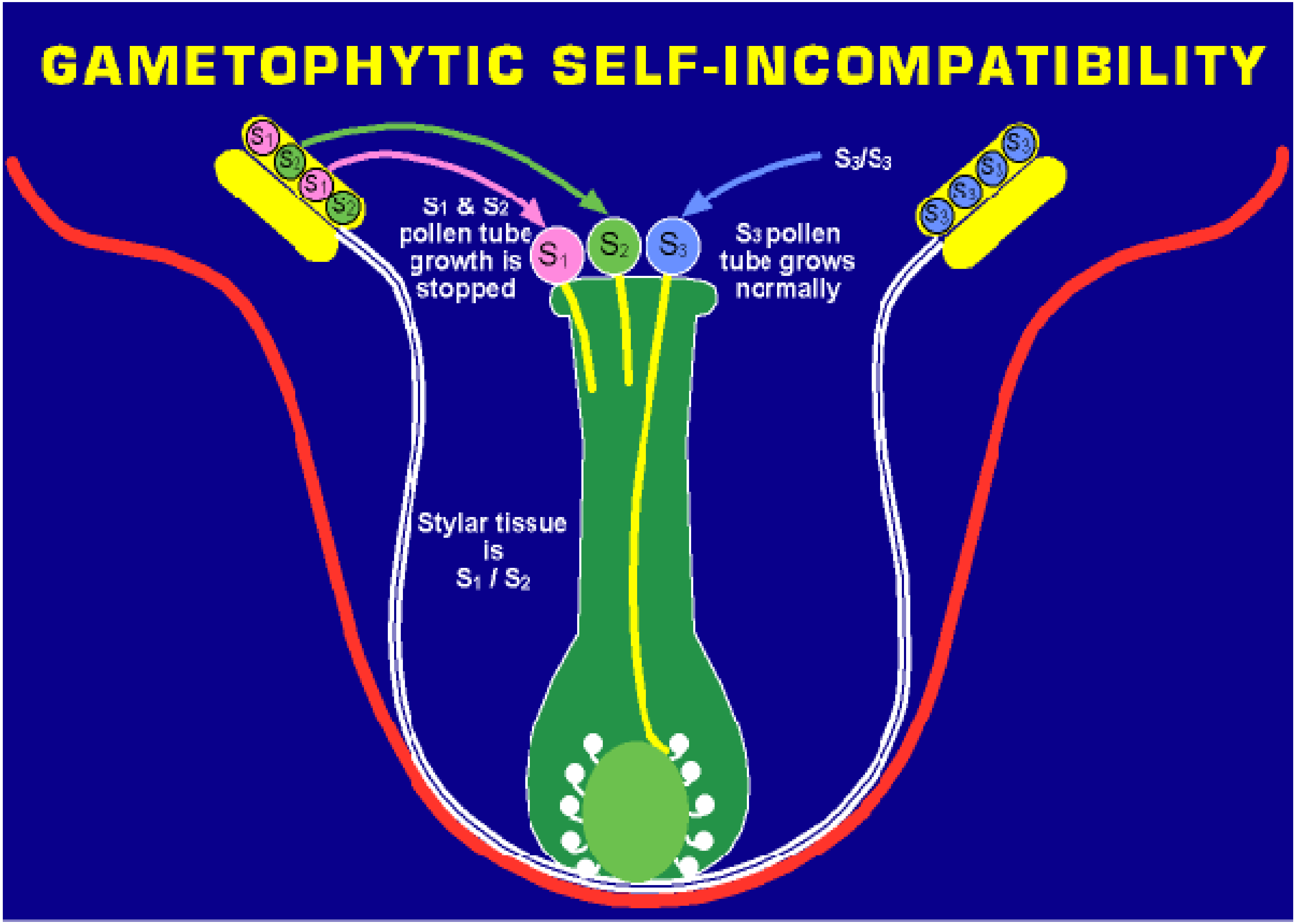
GSI

SI

Self-incompatibility is usually encoded by a single, multiallelic S locus that is composed of one or more male and/or female expressed genes. Allelic differences in the proteins encoded by these genes are believed to be the basis for the recognition of self or non-self pollen.

Mechanism

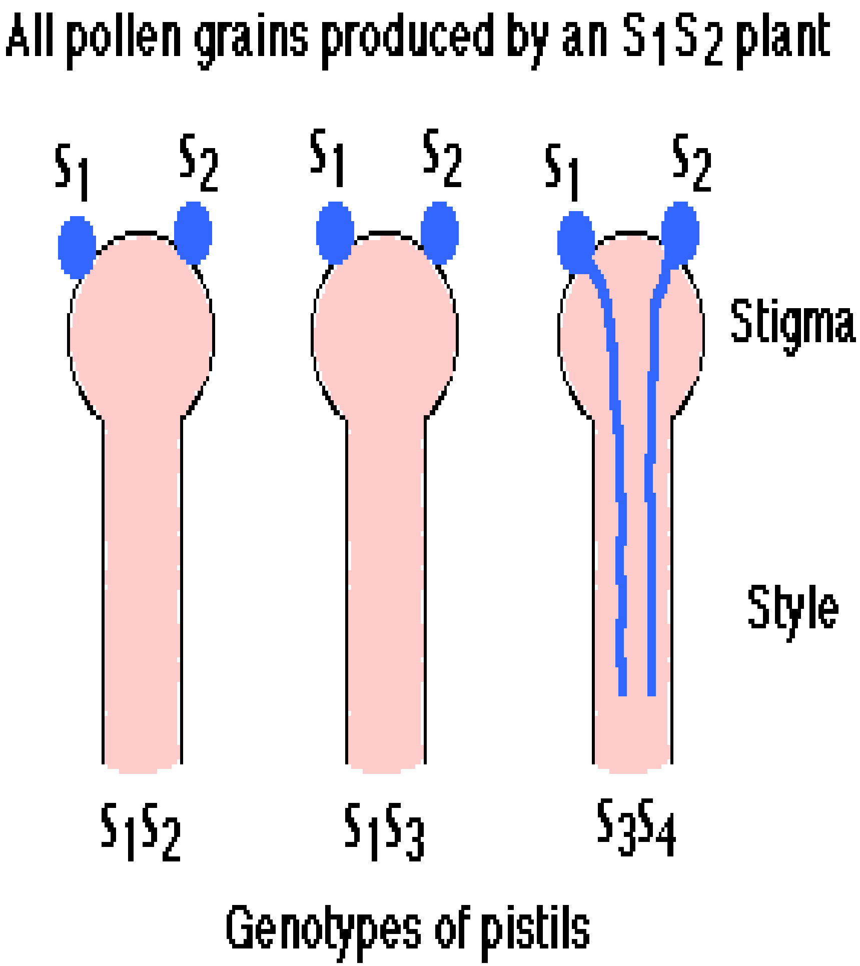



GAMETOPHYTIC SELF-INCOMPATIBILITY
S1
S2
S1
S2
S1 & S2 pollen tube growth is stopped
S1
S2
S3
S3/S3
S3 pollen tube grows normally
S3
S1
S3
S3
Stylar tissue is S1 / S2

GSI

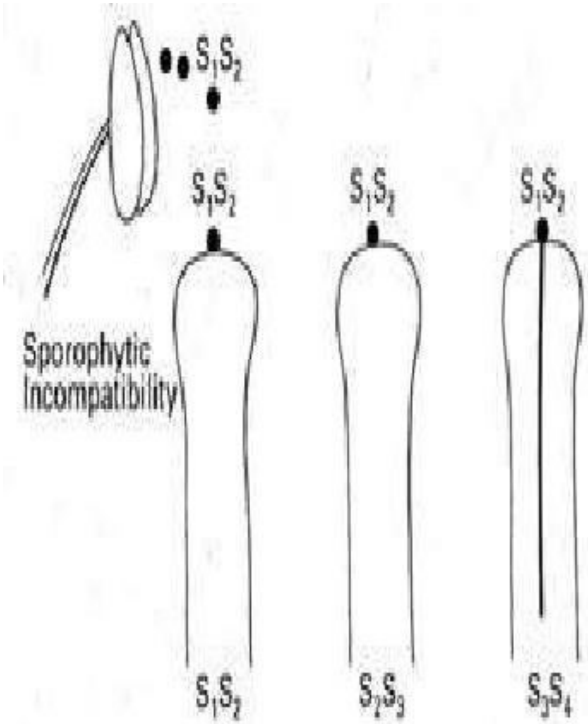
GIS is more common,occurs in one half of all the families. The S loci are polymorphic, that is there is

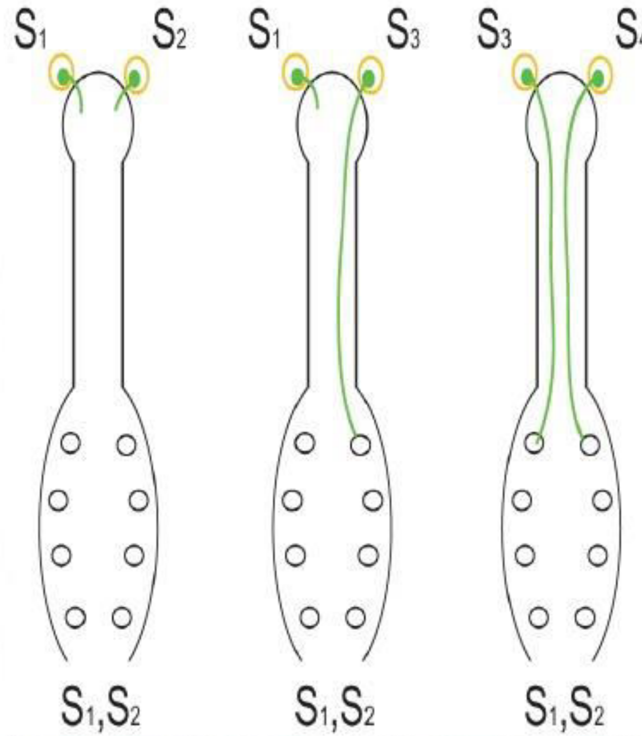
An abundance of multiple alleles in the population. Incompatibility is controlled by the single S allele in the haploid pollen. Thus a pollen grain will grow in any pistil that does not contain the same allele (so, as shown here and in contrast to what happens in SSI, S_2 pollen from an S_1S_2 parent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



GSI - mechanism

- 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**.
- The RNase molecules contain a **hypervariable region** which is the basis for each S specificity (S_1, S_2, S_3, etc.).
- The RNase appears to enter the pollen tube but then destroys RNA only in incompatible ("self") tubes.
- How the pollen tube is able to deactivate the RNase from compatible ("nonself") styles and not the one from incompatible styles remains to be discovered.





Sporophytic self incompatibility

Gametophytic self incompatibility