FERTILIZATION (Contd.)

POLLEN - PISTIL INTERACTION

The stigma is the receptive surface for pollen grains. The function of stigma is to accept the pollen and to ~~prevent~~ permit germination. The stigma can provide nutrients to the pollen and direct the pollen tube growth. It is also involved in the regulation of the flower metabolism. The morphology of flower shows great diversity. stigmas are divided into two categories.

(i) wet stigmas - binucleate pollen
(ii) Dry stigmas - trinucleate pollen

The nature of stigma coverings seems very complex and till now no generalization can be made. The exudate of wet stigma have been studied in some species. The main components are aminoacids, lipids and antioxidants and proteins. Whereas alkaloids shows a variation. The exudate of dry stigma differ in quantity. Lipophilic substances and polysaccarides are present in general. Sometimes polyphenols, tanins or flavonoids can accumulate in the exudate. These products are formed by the papillate cells.

Possible steps and events in Pollen - Pistil interaction after pollination.

	Steps	Events
Pollen Stigma interaction	Contact pollen Coating with stigma coating.	Hydrophyllic typhie and lipophylic pollenkitt in contact with proteinaceous pellicle or exdate result in sticking reaction.
	Attachment of Pollen to Stigma	Signals of recognition, such as by glycoprotein, by electrochemical way or by membrane components as lipoproteins. Charges of stigma coating, as activation of esterase.
	Acceptance of pollen by stigma	Imbition and hydration of pollen. Outflow of pollen-wall components. Signals of acceptance, such as by polypeptides or by membrane components as lipoproteins.
	Rejection of Pollen	No hydration of pollen callose formation in stigma surface cells.
Germination	Activation of pollen	Activation of pollen metabolism excretion of enzymes affecting the stigmatic surface, as cutinase.

	Germination of Pollen	Formation of pollen tube, closure of non-functional pores. Production and excretion of enzymes.
	Rejection of pollen tube	Possible growth of the tube stops after contact with the stigmatic surface.
Pollen tube growth.	Penetration in the stigmatic tissue	Zonal organisation of pollen tube cytoplasm and vacuolation. Dissolution of intercellular substance and cell walls. Conversion and use of dissolved materials. Use of products of stigmatic tissue.
	Directed growth of the pollen tube.	Changes in storage products of the pollen and stylar cells in the transmitting tissue. Stylar cell degradation. Attraction of pollen tube, absence callose plug formation. Signal of acceptance probably of proteins.
	Growth of pollen tube stops.	Pollen tube growth stops after rejection and lack of nutrition.

POLLEN IN-COMPATIBILITY.

Pollen incompatibility reaction after pollination in angiosperms are mainly manifested either in stigma, style or ovule. The pollen does not germinate, tube growth is blocked on the stigma, in the style, in the ovary or the pollen tube stops near the embryo-sac and fusion of sperm cells does not take place.

The incompatibility is genetically based on one S-locus with many alleles or has two (S and Z) or more genes. The expression of the gene activity can be manifested either in the sporophyte or the gametophyte.

In the sporophytic incompatibility the products are probably of proteinaceous nature and are formed in the tapetum and are added to the exine of the pollen grains. These products are set free on the stigma and are involved in a complementary reaction.

In the gametophytic incompatibility the products involved are formed in the pollen during their development. These products are stored in the intine and are released during pollination on the stigma or shortly after pollination. Other sporophytic tissues such as stigma, style or ovule, as well as the embryo-sac are involved in the production of incompatibility substances.

SEXUAL INCOMPATIBILITY

Sexual incompatibility may be interspecific (between individuals of different species) or intraspecific (between individuals of the same species). Later is also called self-incompatibility.

Interspecific incompatibility is heterogenic ie - controlled by more than one gene at different loci on the chromosomes. It prevents free cross-pollination and is the basis of creation of new races and species. In incompatible interspecific crosses either fertilization does not occur or syngamy is followed by abortion of hybrid embryo due to inadequate development of endosperm or embryo-endosperm incompatibility.

SELF IN-COMPATIBILITY

A large no. of flowering plants are outbreeders, which meant that they are successfully fertilized only by the pollen of the other plants and not by their own. In nature different floral adaptations such as dichogamy, herkogamy and unisexuality have evolved to prevent self-pollination by the most widespread and effective natural device to enforce outbreeding is self-incompatibility, which refers to the inability of a plant producing functional male and female gametes to set seeds when self-pollinated.

GENETIC BASIS OF SELF INCOMPATIBILITY

Self-incompatibility is a widespread mechanism in flowering plants that prevents inbreeding and promotes outcrossing. The self-incompatibility response is genetically controlled by one or more multi-allelic loci and relies on a series of complex cellular interactions between the self-incompatible pollen and pistil.

In most cases self-incompatibility (SI) has been found to have a simple genetic basis involving a single locus, referred to as the S-locus, with multiple alleles. When pollen and stigma express the same allele at the S-locus, fertilization does not occur. Two major classes of SI system have been identified, distinguished primarily by the genetic control of pollen incompatibility -

(i) GSI - Gametophytic self incompatibility
(ii) SSI - Sporophytic self incompatibility

Let us consider a plant having S_1 and S_2 alleles in its sporophytic cells, including the pistil Fig I. During microsporogenesis such a plant will produce two types of pollen; one half carrying the S_1 allele and the other half S_2 allele. According to the "oppositional S-allele" concept proposed by East and Mangelsdorf 1925, neither of these pollen type (S_1 or S_2) would be able to bring about fertilization in the style of this particular plant (Fig I A) because both the alleles are present in

the stylar cells.

On the other hand, if this plant is pollinated with the pollen from a plant of S_2S_3 genotype, 50% pollen grains carrying S_3 allele, would be functional whereas the remaining 50% carrying S_2 allele would be non-functional (Fig IB). However, every pollen grain from S_3 and S_4 plant would be functional on the pistil of a S_1S_2 plant, (Fig IC) as none of the allele is common between these two plants. It should be emphasised at this stage that in all situations described so far it is the s-allele of the pollen or the male gametophyte which determines the incompatibility reaction (GSI).

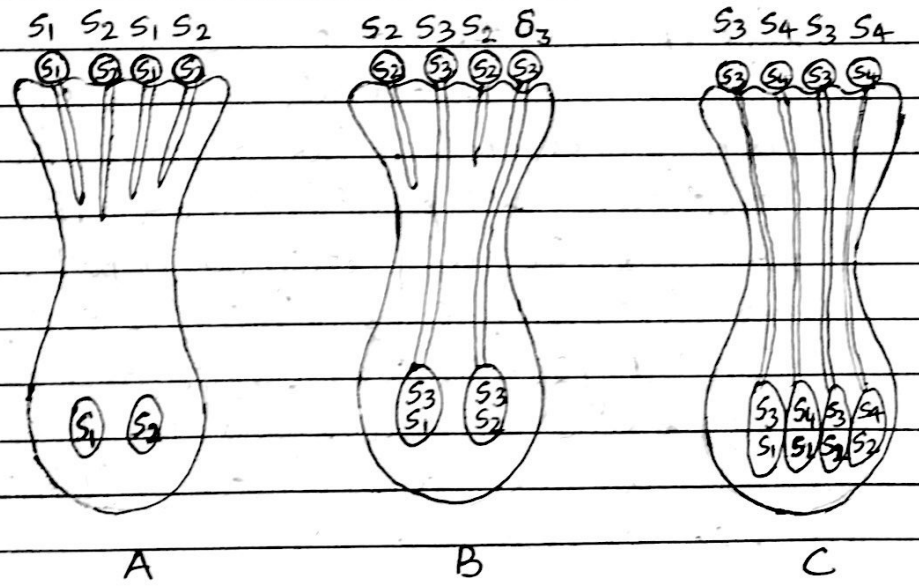

Fig-I

Fig I Response of pollen on a pistil of S_1S_2 plant showing gametophytic self-incompatibility. (GSI)

A = None of the pollen from a $S_1 S_2$ plant is able to effect fertilization

B = From a $S_2 S_3$ plant only S_3 pollen succeed in fertilizing the ovule.

C = All the pollen from $S_3 S_4$ plant bring about fertilization

In SSI system all the pollen of a plant behave similarly, irrespective of the S-allele they carry. For instance, from a plant carrying $S_1 S_2$ alleles the pollen carrying S_1 or S_2 allele would behave as S_1 if S_2 is dominant, if there is no dominance both will behave as S_1 plus S_2. In other words, the presence of even one of the allele of the stylar tissue in the sporophytic tissue of the male plant would render all the pollen of the plant non-functional with respect to that particular style (Fig II). A $S_1 S_2$ would therefore be completely incompatible to plant carrying $S_1 S_2$ (Fig II A), $S_1 S_4$, $S_1 S_5$ or $S_2 S_3$ (Fig II B), $S_2 S_4$, $S_2 S_5$ and so on, but would show 100% compatibility with a plant carrying $S_3 S_4$ (Fig II C), $S_3 S_5$ and so on.

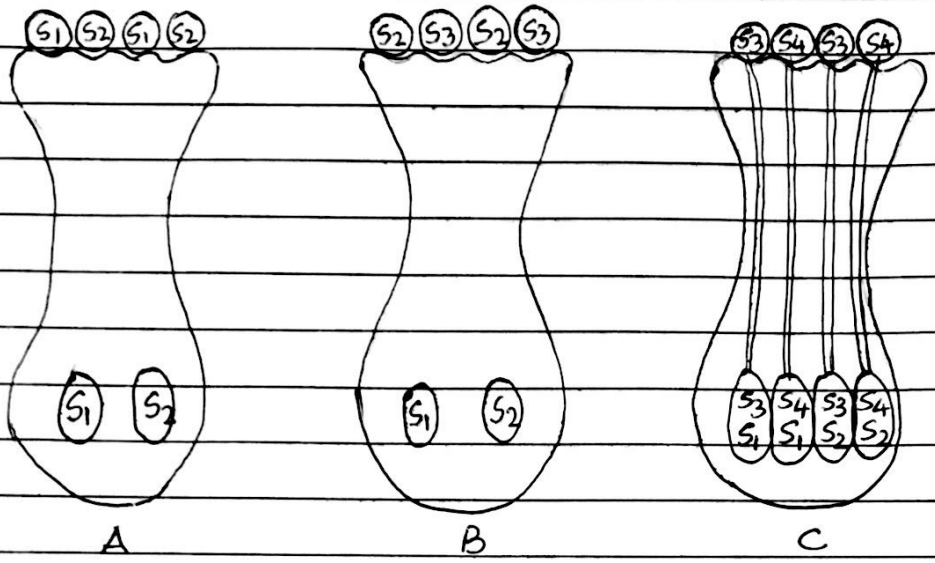

Fig II

Respose of pollen of a pistil of S_1S_2 plant, showing Sporophytic self-incompatibility. (SSI) None of the pollen from S_1S_2 (A) or S_2S_3 (B) plant can bring about fertilization, but every pollen of a S_3S_4 plant is capable of fertilization -(C).