Cytoplasmic Inheritance

Definition : The Transmission of characters controlled by plasma genes is called Cytoplasmic Inheritance or Extra Chromosomal Inheritance. Described by Correns in 1908.

Plasmogenes or Self replicating and transmitted by cytoplasm only.
Like Chromosomal genes, these are also capable of mutation.
The offsprings receive Cytoplasm only from female gamete, not from male gamete. As a result, Cytoplasmic inheritance is known as Maternal Inheritance (Plasma genes of female parent alone are contributed to the offsprings)

The results of reciprocal crosses are not same in Cytoplasmic Inheritance.

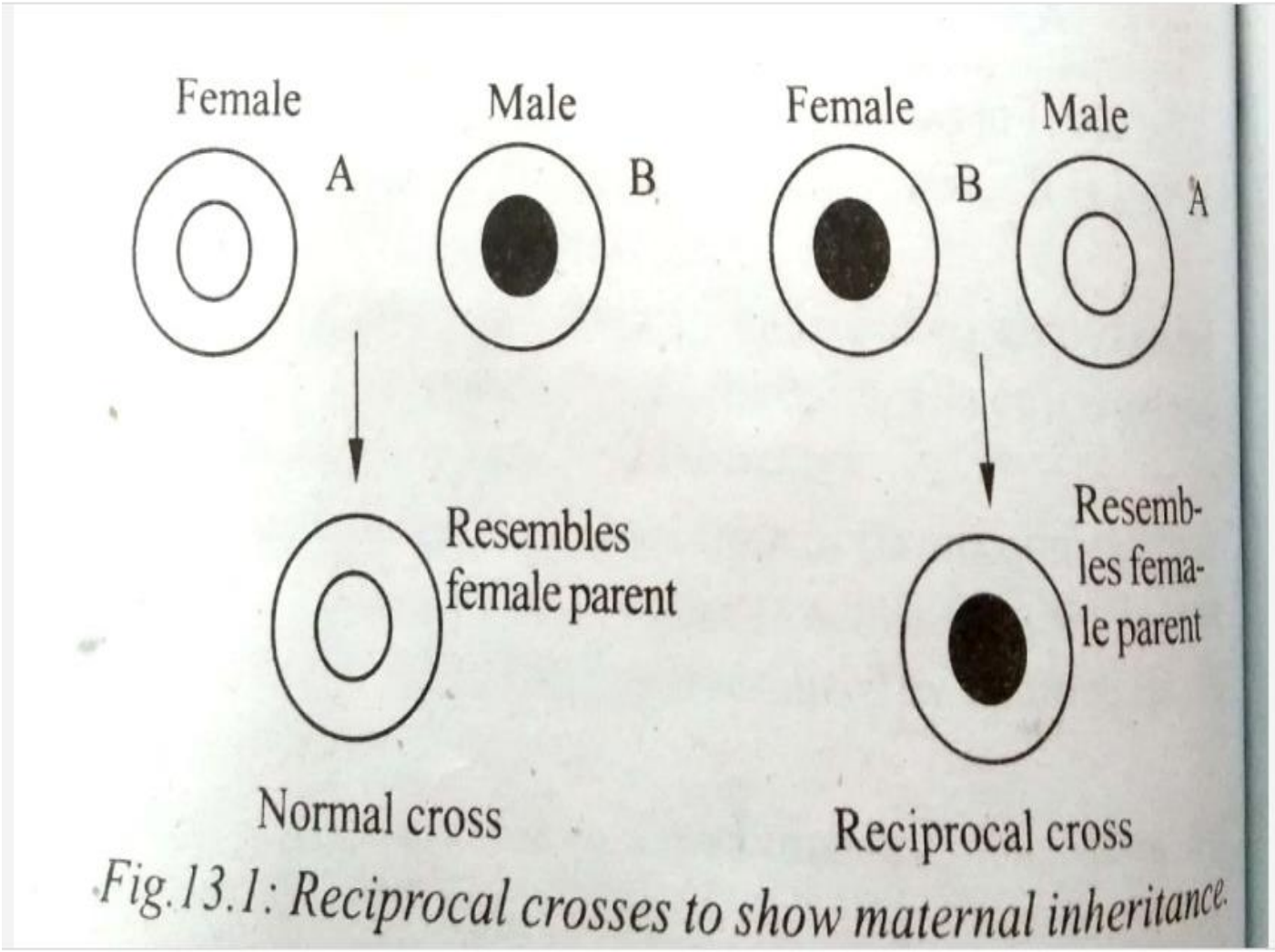

Fig.13.1: Reciprocal crosses to show maternal inheritance.

Kappa Particles in Paramecium

Two Strains in Paramecium (i) Killer (ii) Sensitive

Killer Strain produce toxic substance - Paramecin, which kills the other type.

Production of Paramecin in killer type controlled by Cytoplasmic Particles – "Kappa Particles".

In sensitive Strain lack Kappa Particles.

The Kappa Particles pass from one generation to other during cell division.

These particles also multiply during division & transmitted through Cytoplasm.

The multiplication of Kappa particles is controlled by dominant nuclear gene **"K"**. **The gene "K" can only maintain Kappa particles but cannot initiate its production.**

When killers **KK** conjugate with non-Killers **kk**, the ex- conjugants are **Kk**.

The development of particular type depends on the duration of Cytoplasmic exchange. In normal case of Conjugation, the nuclear material alone is exchanged & there is no exchange of Cytoplasmic material. In such cases, each ex conjugant gives rise to the organism of its own type i.e. the killers -> killers & non killer -> non killer ex conjugant.

- Sometimes the conjugation period is prolonged & cytoplasmic bridge between the two conjugant is larger.
- In such cases, in addition to the nuclear material, the cytoplasmic material are also exchanged. During this time, the Kappa particles present in the cytoplasm of the killer type enter the non killer type& convert it into killer type. Hence, the offsprings produced by the ex conjugants are killer type. This shows that paramecium becomes a killer, when it receives Kappa particles & it becomes sensitive when it does not deceive Kappa Particles.

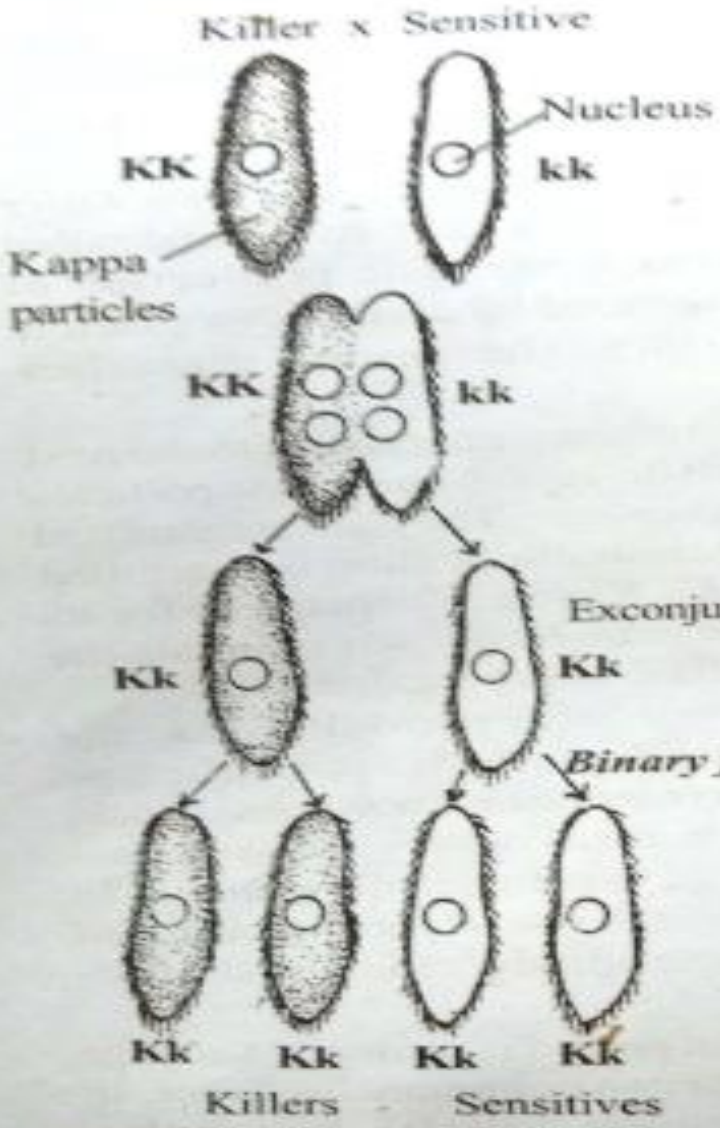

Fig.13.2: Conjugation without cytoplasmic exchange.

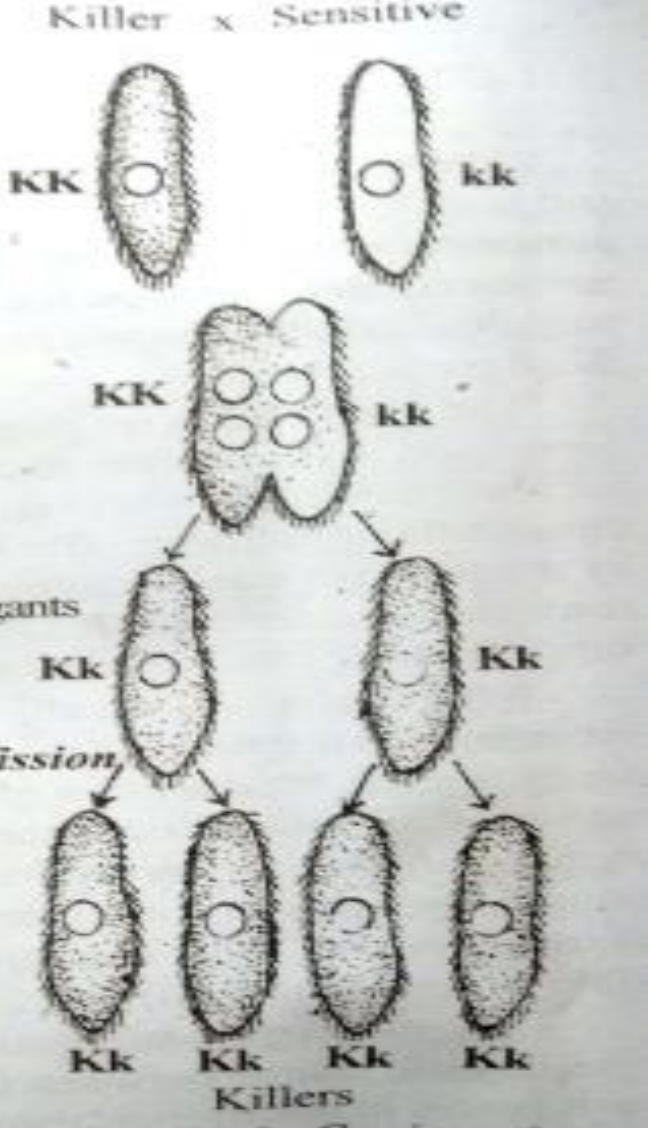

Fig 13.3: Conjugation with cytoplasmic exchange.

Shell coiling in Snail

- In Snail Limnaea, the nature of shell coiling is under cytoplasmic inheritance.
- The phenotype of the offspring is determined by the genotype of the female parent- Maternal inheritance.
- In shell coiling, the genotype of the female parent is not expressed in its own body, but in the offsprings of F1 generation hence it is called delayed inheritance.

- In reciprocal crosses, results are different.
- Shell coiling – 2 types

  (i) Dextral (clockwise)

  (ii) Sinistral(anti clockwise)
- The dextral shell is dominant- genes DD
- The Sinistral shell is recessive- genes dd
- When female dextral snail(DD) is crossed with male Sinistral snail(dd) – F1 snails(Dd) dextral like female parent.
- When female sinistral snail (dd) is crossed with male dextral snail(DD)- F1 snails(Dd) sinistral like female parent.

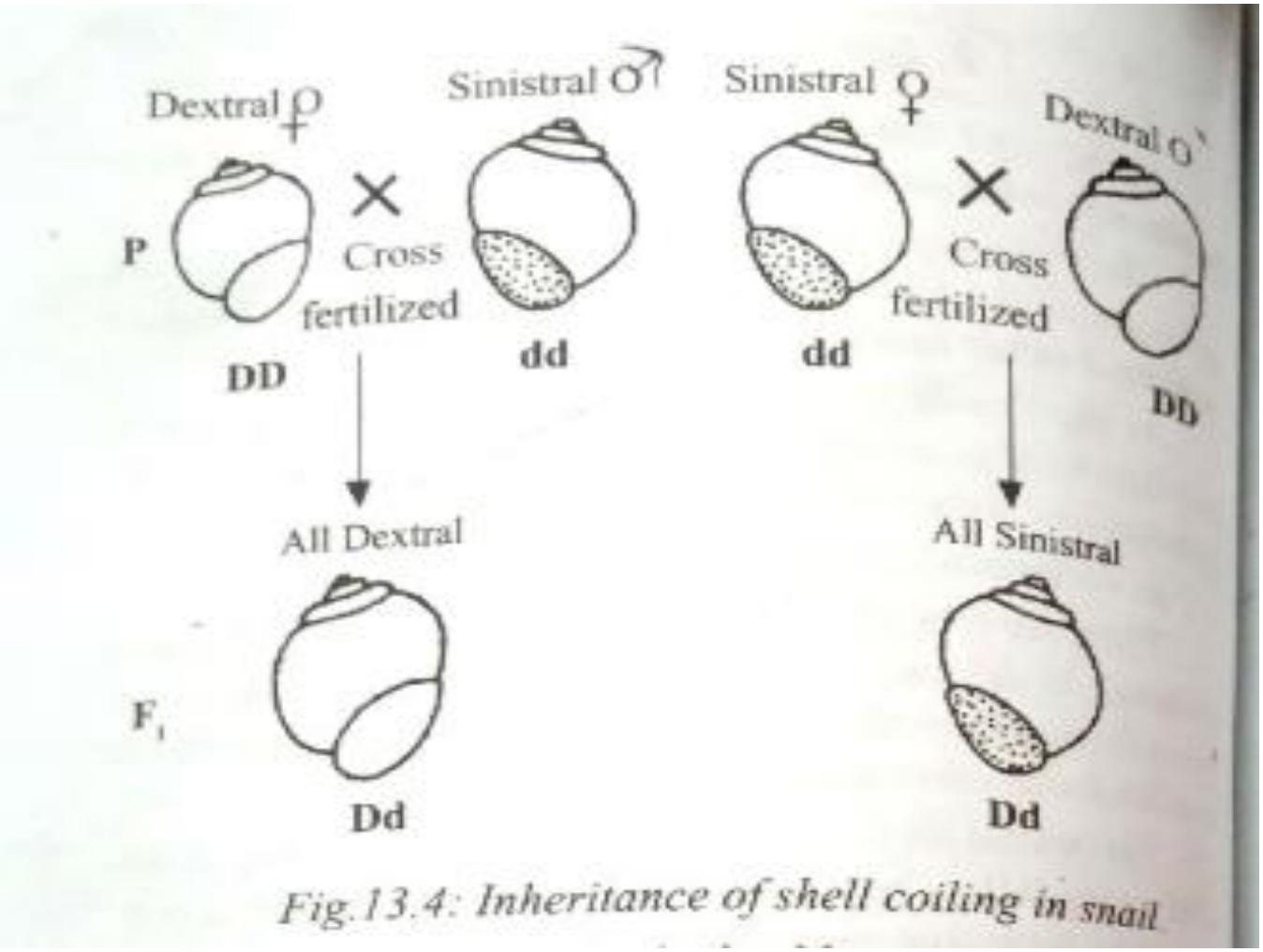

Fig.13.4: Inheritance of shell coiling in snail

- In the above 2 crosses, F1 Snails have same genotypes, but different phenotypes.
- Here phenotype of offsprings determined by genotype of mother.
- In first cross, the offsprings : Dextral shell because mothers genotype is “DD”
- In second cross, the offsprings : Sinistral shell because mothers genotype is “dd”
- Thus in reciprocal crosses, results are different.

- The F2 generation is obtained by seil fertilization of single snail (hermaphrodite)
- When dextrally coiled F1 Snail (Dd) is self fertilized F2 offsprings appear in the genotypic ratio 1DD:2Dd:1dd. But Phenotypically, all the

F1 individuals are dextral, because the parental genotype(Dd has dominant gene D.

When Sinistral F1 Snail(Dd) is self fertilized, all the F2 offsprings dextral because parental genotype(Dd) has ‘D’ gene.

- The inheritance of shell coiling follows simple mendelian character.
- In F2 generation the genotypes appear in ratio1DD:2Dd:1dd.
- The phenotypic ratio 3:1 of F2 generation appear only in F3 generation. This is due to delayed inheritance.

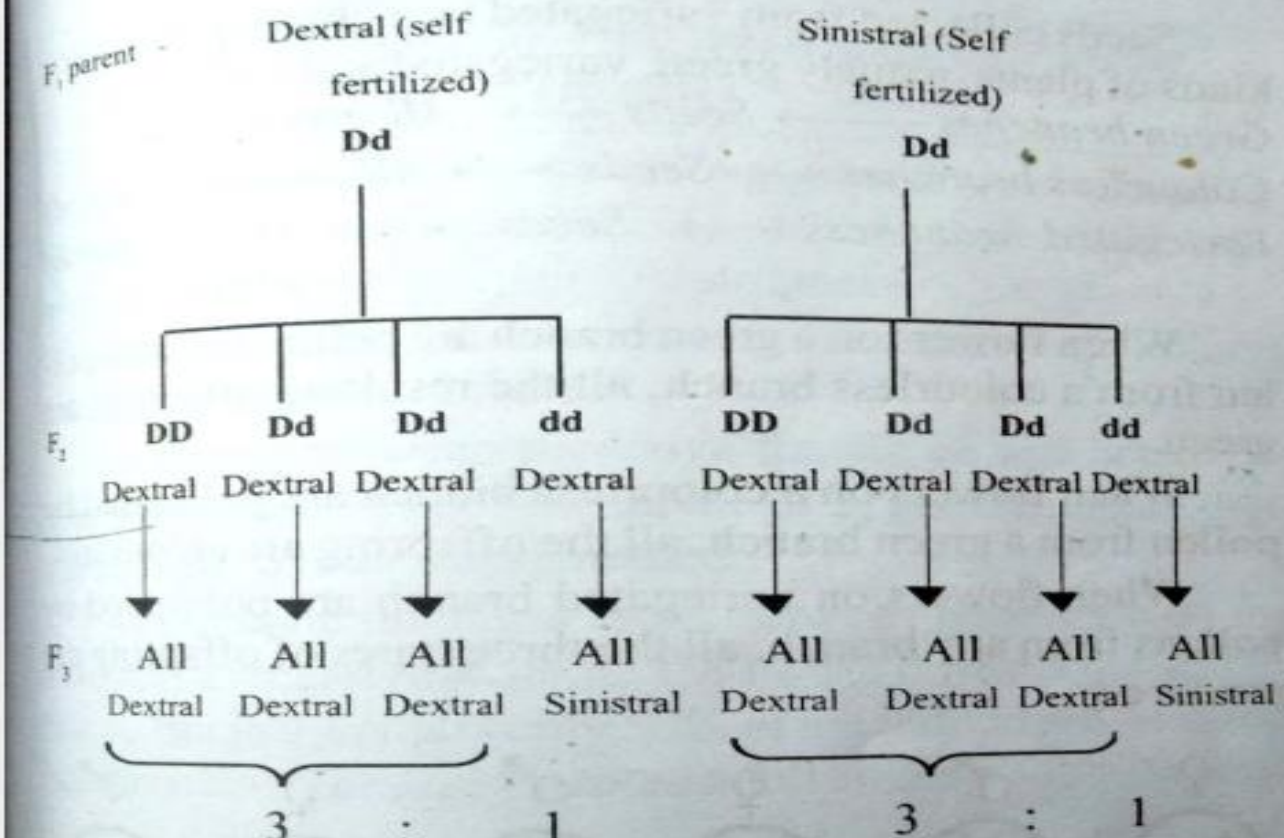

Fig.13.5: Inheritance of shell coiling in F_2 and F_3 generation.