EXTRA-CHROMOSOMAL
AND
CYTOPLASMIC INHERITANCE

B.Sc. IInd Semester(Zoology)

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INTRODUCTION

The inheritance of most of the characters of an individual is governed by nuclear genes. But in some cases, the inheritance is governed by cytoplasmic factors or genes. When the transmission of characters from parents to offspring is governed by cytoplasmic genes; it is known as cytoplasmic inheritance or extra nuclear inheritance or extra chromosomal inheritance or non-mendelian inheritance or organellar inheritance.

EVIDENCES OR CHARACTERS IN FAVOUR OF CYTOPLASMIC INHERITANCE

1. Reciprocal Crosses :

Characters which are governed by cytoplasmic inheritance invariably exhibit marked differences in reciprocal crosses in F1, whereas in case of nuclear inheritance such differences are not observed except in case of sex linked genes.

2. Maternal Effects:

In case of cytoplasmic inheritance, distinct maternal effects are observed. This is mainly due to more contribution of cytoplasm to the zygote by female parent than male parent. Generally ovum contributes more cytoplasm to the zygote than sperm.

3. **Mappability:**

Nuclear genes can be easily mapped on chromosomes, but it is very difficult to map cytoplasmic genes or prepare linkage map for such genes. Now chloroplast genes in Chlamydomonas and maize, and mitochondrial genes in human and yeast have been mapped.

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4. Non-Mendelian Segregation:

The mendelian inheritance exhibits typical segregation pattern. Such typical segregation is not observed in case of cytoplasmic inheritance. The segregation when occurs, is different from mendelian segregation.

5. Somatic Segregation:

Characters which are governed by cytoplasmic genes usually exhibit segregation in somatic tissues such as leaf variegation. Such segregation is very rare for nuclear genes.

6. Infection-Like Transmission:

Cytoplasmic traits in some organisms exhibit infections like transmission. They are associated with parasites, symbionts or viruses present in the cytoplasm. Such cases do not come under true cytoplasmic inheritance.

7. Governed by Plasma Genes:

The true cases of cytoplasmic inheritance are governed by chloroplast or mitochondrial DNA called plasmagens.

EXAMPLES OF CYTOPLASMIC INHERITANCE

Cytoplasmic inheritance in *Paramecium* (T.M. Sonneborn 1943)

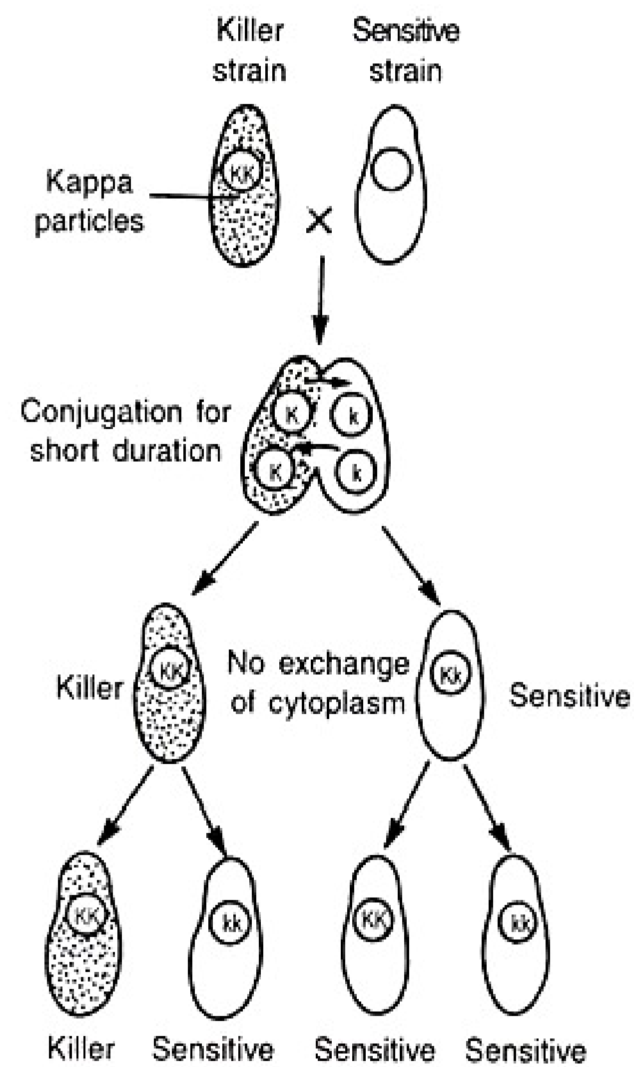
- Kappa Particles in Paramecium:
- There are two types of strains in Paramecium. One has kappa particles in its cytoplasm and other does not have such particles. The presence of kappa particles in the cytoplasm leads to production of a toxin known as paramecin. This toxin can kill the strain of Paramecium which lacks kappa particle. Thus, the strain with kappa particle is known as killer strain and that without kappa particle is called as sensitive strain.
- Multiplication of kappa particles in the cytoplasm takes place by fission. However, their multiplication is governed by a dominant nuclear gene (K). They can multiply in the homozygous dominant (KK) or heterozygous (Kk) individuals.
- Kappa particles cannot multiply in recessive (kk) individuals. Even if kappa particles are introduced into kk strains, they will gradually disappear due to their inability to multiply and the strain will become sensitive.
- Though the multiplication of kappa particles is dependent on nuclear genes, their action is independent of nuclear gene. The inheritance of kappa particles can be studied by conjugation between killer and sensitive strains.

The conjugation may be of two types:-

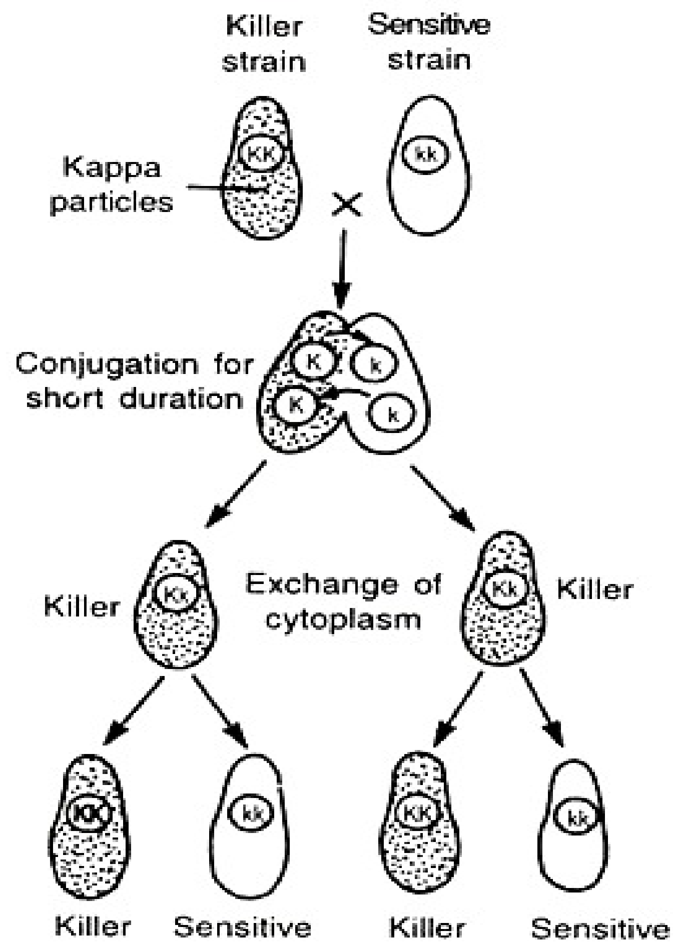
(a) Short Duration Conjugation:

Short duration conjugation leads to exchange of nuclear genes between the killer and sensitive strains. Exchange of cytoplasm does not take place in such conjugation. Thus, the ex-conjugants will be heterozygous (Kk) for killer gene.

However, the strain with killer cytoplasm produces killer (KK) and sensitive (kk) strains by further division, whereas the sensitive stain produces only sensitive strains (kk) by further division. This clearly indicates that the killer character is not governed by nuclear gene.



(b) Long Duration Conjugation: Such conjugation between killer and sensitive strains leads to exchange of both nuclear genes as well as cytoplasm. Here both the ex-conjugants are heterozygous (Kk) but killer. Autogamy of both the ex-conjugants produces killer and sensitive strains in 1 : 1 ratio. This has demonstrated that kappa particles have cytoplasmic inheritance

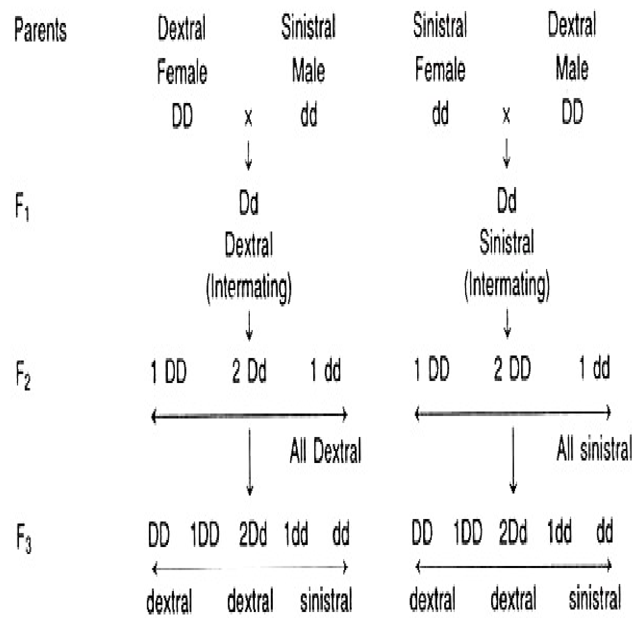


COILING PATTERN OF SHELL IN SNAIL

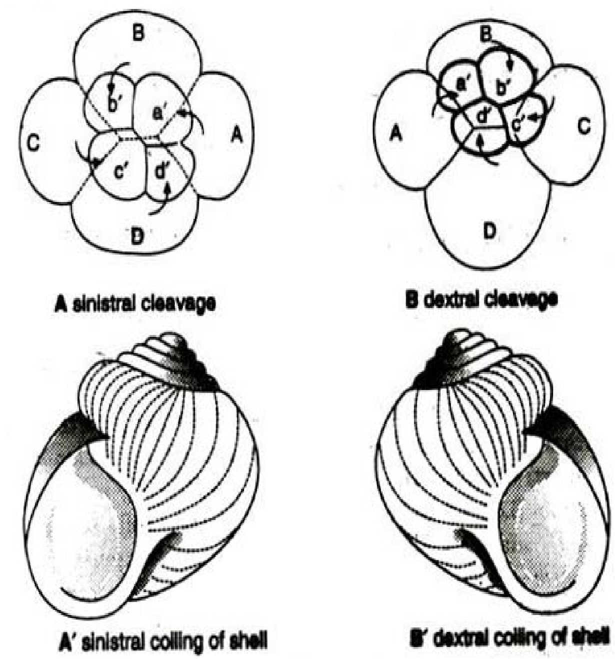
There are two types of coiling pattern of shell in snail (*Limnaea peregra*)- Right handed (dextral) and Left handed (sinistral).

The coiling behaviour is controlled by a single gene. The dextral coiling behaviour is governed by dominant allele D and sinistral by recessive allele d. When a cross is made between dextral female and sinistral male, it produces dextral snails in F1 as well as in F2.

However, in F3 a segregation ratio of 3 dextral and 1 sinistral is observed. Similarly, when a reciprocal cross is made, i.e., sinistral as female and dextral as male, all the snails are sinistral in F1 and dextral in F2. Again in F3 a ratio of 3 dextral and 1 sinistral is observed. This indicates that the inheritance of coiling direction in water snail depends on the genotype of female parent and not on its own genotype.



The maternal genotype affects the organization of egg cytoplasm. In other words, it affects the orientation of first cleavage plain in the zygote. If it is tilted to the left, successive cleavages will produce a spiral to the left. If it is tilted to the right a dextral pattern will follow (Suzuki and Griffiths, 1976).



MILK FACTOR IN MICE

- This is an interesting example of cytoplasmic inheritance. It is found that certain types of mice are very susceptible to mammary cancer and this characteristic is found to be transmitted maternally. The results of reciprocal cross between susceptible mice and low-incidence mice depend on the trait of female parent.
- When the young mice of low cancer incidence parent are allowed to feed milk by a susceptible foster mother, it produce, a high rate of cancer in them. Hence this is a case of infective agent transmitted in the milk. The milk factor responsible for causing cancer is possibly a virus. The presence of milk factor depends on nuclear gene.

Please stay home

stay safe and

urge others to stay home as well

THANK YOU.....