RAMA UNIVERSITY

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FACULTY OF AGRICULTURAL SCIENCES

AND ALLIED INDUSTRIES

CYTOPLASMIC INHERITANCE

It is not only the nuclear genes but also a variety of extra nuclear substances that are transmitted from generation to generation. In plant cells, plastids, mitochondria localized in the cytoplasm have been shown to be responsible for the extra nuclear transmission of inherent qualities like the nuclear genes, they are capable of specific self-duplication. They are transmitted from generation to generation.

They totality of heredity transmitted through the cytoplasm is referred to as plasmon, and all cytoplasmic particles which manifest genic properties viz., self duplication, specificity and mutability are called " plasma genes'.

Inheritance of plastids in Merabilis:

The inheritance of plastids in Four 'O' clock plant M*eiabilis jalapa* was first described by Correns (1908). In M. Jalapa, some of the branches may have normal green leaves, while in the same plant, some other branches may have only pale green or white leaves and still others may have variegated leaves. Flowers on branches with normal green leaves produce seeds that grow into plants with normal green leaves irrespective of whether they are pollinated by pollen from branches with normal green variegated or pale green leaves.

Progeny of a Variegated four 'O' clock plant

Type of branch from which flowers are chosen for pollination	Type of branch from which pollen was obtained	Type of leaf in the progeny grown from seed
Green	Green,	Only green
	variegated,	"
	pale green	"
Variegated	Green	Green, variegated, or pale
	Variegated	"
	Pale green	"
Pale green	Green	Green, pale green
	Variegated	"
	Pale green	"

It is clear that variegation is determined by agencies transmitted through the female and that it is not influenced by the type of pollen used. These agencies are the chloroplast. They are capable of self-duplication and are transmitted from generation to generation through the cytoplasm of the egg. Seeds borne on a green branch have three gene only green plastids, seeds borne on a pale green branch have three gene only pale green plastids and seeds borne on a variegated branch have green or pale green or a mixture of the two types of plastids.

Variegation is thus a heredity character determined by stable, self-duplicating, extra nuclear particles called plastids. Neither the nucleus of the female gamete nor the male gamete is involved in the control of this type of heredity character.

Maternal inheritance by 'iojap' gene in maize

The egg regularly contributes much more cytoplasm to the next generation than does the sperm. It should therefore be expected that in cases of cytoplasmic inheritance, differences between reciprocal crosses would result.

Rhoades (1946) identified the 'iojap' gene (ijij) in maize located in chromosome VII controlling plastid inheritance in the plant. The gene 'Ij' is responsible for the normal green colour of the plant.

When normal green plants with IjIj are used as female and pollinated by pollen from stripped with ijij, F1 plants are wholly green.

1. Green x stripped

↓

E Γ

Ij Ij ij ij

F1 Ijij Green

F2 3 green : 1 Iojap.

When striped with ijij are pollinated by pollen from the normal green plants with IjIj the F1 plants, all of which have the same genotype. Ijij are of 3 different phenotypes.

Stripped ijij X Green Ij Ij

E (Iojap) Γ

F1 Ijij Green, stripped or white (Iojap)

When plants with same genotype Ijij have different phenotype viz., normal green, stripped or white, the differences can be attributed only the differences in plastids.

Cytoplasmic male sterility in Maize

In case of male sterility in maize, pollen grains of such male sterile are aborted. This male sterility is transmitted only through the female and never by the pollen. When all of the chromosomes of the male sterile line were replaced with chromosomes of normal plants, the line still remained male sterile, showing thereby that male sterility in controlled by some agency in the cytoplasm. It was later recognized that cytoplasmic male sterility in maize results from alterations in the heredity units in the mitochondria (mitochondrial DNA).

Inheritance of Kappa particles in Paramecium

In *Paramecium aurelia,* two strains of individuals have been reported. One is called as ' Killer' which secretes a toxic substance ' paramecin' and the other strain in known as ' sensitive' and is killed if comes in contact with the 'paramecin'. In the cytoplasm of the killer strain the kappa particles (cytoplasmic – DNA) are present kappa particles are absent in sensitive strains. The transmission of kappa particles is through cytoplasm but maintenance of kappa particles and production of paramecin is controlled by 'k' we assume that the killer strains carry dominant allele 'kk; and that sensitive 'kk'.

On conjugation, conjugents exchange their nuclear material so that ex-conjugants 'kk' resulted from conjugants 'kk' and 'kk' when conjugation is for normal time, then only nuclear material is exchanged and therefore killer will produce killer daughters and sensitive will produce sensitive daughters. But if the conjugation is in longer period, there will be exchange of cytoplasm resulting in the inheritance of kappa particles by both the ex-conjugants so that all the daughter paramecia produced are killers because all inherit the kappa particles through the mixing of cytoplasm. Therefore this trait is transmitted through cytoplasmic heredity. The trait is only stable is killer strains.

Inheritance through mitochondria

Mitochondria can self-replicate and represent another genetic system in the cell. Of course, the amount of mitochondrial DNA is so small, representing less than 1% of the nuclear DNA is mammalian cells and it can code for a part of the protein in the mitochondria. The synthesis of the cytochrome found in mitochondria for example, is known to be present in minute amount in cytoplasm under the control of nuclear genes. Therefore, it is suggested that both mitochondria and chloroplast seem to have a semi-autonomous existence and their DNA forms the basis for genetic systems separate from that in the nucleus.

EPISOME IN BACTERIA

Some hereditary particles have been found to exist in two states, either in an autonomous state in the cytoplasm, where they replicate in dependently, of the chromosomes, or in an integrated state incorporated into the chromosome. Particles with such properties are known as episomes and include such things as the sex factor. The episomes are apparently not essential to the life of the bacteria, because they may or may not be present. If they are absent, they can be acquired only from an external source.

In bacteria, E coli, sex is determined by the presence or absence of the sex factor (F). Male bacterial cells (donor) have the sex factor and this factor is responsible for the transfer of DNA from male to female bacterial cells (Recipient). This sex factor is the cytoplasmic particle.