Cytoplasmic Inheritance

Chromosome theory of inheritance suggested that Mundelein factors or genes were located on chromosomes. This theory was proved to hold good through a variety of experimental evidences. Since the chromosome complement in male and female gametes obtained from same individual would be similar, reciprocal crosses **(♀A x ♂B: ♀B x ♂A)** should give same results. The only exception to this expectation, earlier studied in **Sex Linked, Sex Influenced and Sex Limited Traits** is sex linked inheritance. Differences in reciprocal crosses involving sex linked characters can be easily explained on the basis of transmission of sex chromosomes.

Introduction:

There are many exceptions to the rule in genetics. One of them is that not all inherited characters are determined by genes located in the nucleus. A small minority are controlled by genes located in cell organelles in the cytoplasm i.e. cytoplasmic genes, and these of course are exceptions to the chromosome theory of inheritance. Since they are extra chromosomal (i.e. outside the chromosomes), such genes are not subject to the normal rules of Mendelian heredity.

The recent emphasis in evolutionary biology on looking at genes as the unit of selection has focused almost exclusively on nuclear genes.it is a neglected fat that an important component of hereditary material in organsim is non-nuclear, and perhaps more importantantly,I,e this non-nuclear genetic material is inherited in ways that can be radially at varience with nuclear patterens of inheritance,this creates the potential for conflict between nuclear & cytoplasmic genes,partiularly with respect to sex, reproduction, the allocation of parental investment !

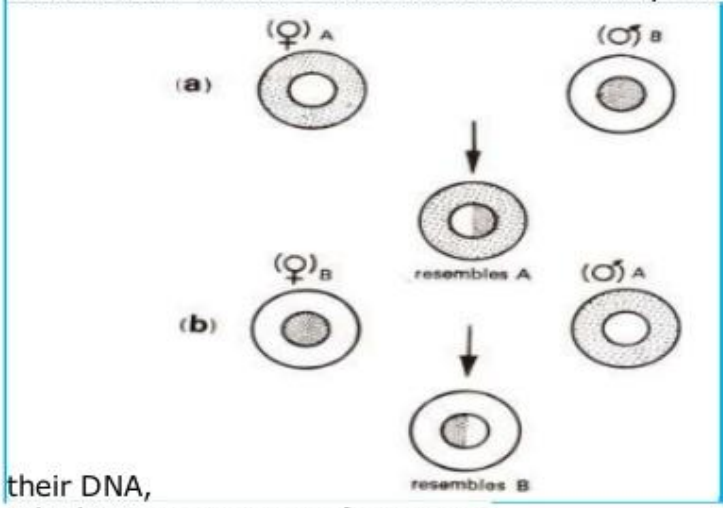
Cytoplasmic inheritance is by no means a rare or aberrant phenomenon but is rather a regular part of the life of every eukaryotic organism (as well as large population in prokaryotes)

Since chromosomes divide in a very precise manner both during mitosis as well as during meiosis, it is easy to draw a parallelism between chromosomes and genes. Cytoplasm, however, does not divide in such a precise manner during cell division. Female gamete usually contributes more cytoplasm to the zygote.

Consequently, for characters having cytoplasmic control, differences in reciprocal crosses would be observed. Inheritance in these cases would be mainly of maternal type as shown in Figure 18.1. As can be seen in the figure, if two strains A and B respectively having genotypes *AA* and *BB* and cytoplasm's a and b are crossed reciprocally, we will get two hybrids *AB* (a) and *AB* (b) (cytoplasm is indicated in parentheses). In case of maternal effect, *AB* (a) and *AB* (b), despite having same nuclear genotype will differ. *AB* (a) will resemble strain A or *AA* (a) and *AB* (b) will resemble strain B *or BB* (b). Since such effects are solely produced by cytoplasm of the egg, they are described as maternal effects. However, maternal effects are often produced due to effect of genes through cytoplasm. In other words, properties of cytoplasm depend on nuclear genes. Such cases can be distinguished from those, where extra chromosomal or cytoplasmic hereditary units are present and function either independently or in collaboration with nuclear genetic system. This is called **extra chromosomal** or **cytoplasmic** or **organelles inheritance**

. We know that in chromosomes, DNA is the sole genetic material and is the storehouse of genetic information. Discoveries of presence of DNA in cell organelles found outside the nucleus is a strong evidence to suggest that genetic information does exist in cytoplasm also. It will be seen in this section, that two important and essential organelles i.e. plastids (in plants only) and mitochondria located in cytoplasm carry DNA. These organelles

control extra chromosomal inheritance in many cases through



their DNA,
Which carries genetic information?

DEFINATION:

Inheritance:

1. The acquisition of characters or qualities by transmission from parent to offspring.
2. That which is transmitted from parent to offspring.

Cytoplasmic inheritance:

The acquisition of traits or conditions controlled by self-replicating substances within thecytoplasm, such as mitochondria or chloro plasts, rather than by genes on the chromosomesin the nucleus. The phen omenon occurs in plants and some animals but has not beendemonstrated in humans.

OR

_A form of non-Mendelian inheritance in which a trait was transmitted from the parent to offspring through nonchromosomal, cytoplasmic means.