

B.N.Bandodkar College of Science, Thane

S.Y.B.Sc – Botany

Paper II Unit 3

By Dr M.S. Mulgaonkar

EXTRA NUCLEAR GENETICS

Introduction:

All inherited characters are not determined by genes located in the nucleus. But some are controlled by genes located in cell organelles in the cytoplasm i.e. **cytoplasmic genes**.

Since they are **extra chromosomal** (i.e. outside the chromosomes), they do not follow the normal rules of Mendelian heredity. There are different types of inheritance pattern. One of them is explained as follows:

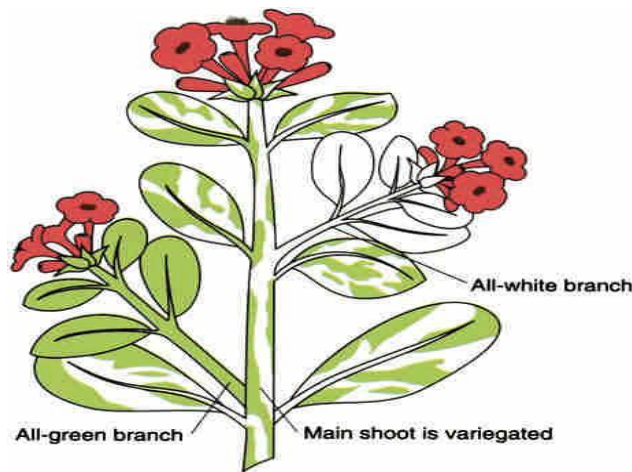
CHLOROPLAST DETERMINES HEREDITY

1. **Plastid transmission in plants** (Leaf variegation in plants) –

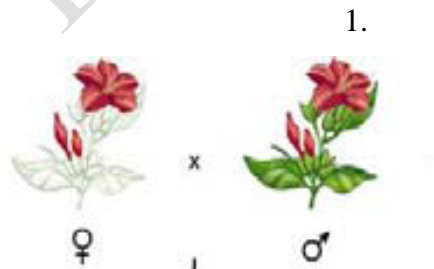
- One big example of cytoplasmic inheritance was that discovered by Correns in a variegated variety of the four-o'clock plant *Mirabilis jalapa*.
- Variegated plants have some branches which carry normal green leaves, some branches with variegated leaves (mosaic of green and white patches) and some branches which have all white leaves.
- Correns in 1909 discovered extra nuclear inheritance of plant plastids.
- Plastids are cytoplasmic organelles which develop from the pro-plastids. The plastids are self-replicating organelles.
- It contains the genetic material i.e. very small DNA.
- Plastids are of 2 types:

- Chloroplast - these organelles contain the chlorophyll, hence provide the green color.
- Leucoplast - the plastid which are without any coloured pigments are called leucoplast.
- If both are present within the same cell then it results in a **mosaic plant**, also called variegated plants ex. Money plant.

Variegated patterns in plants

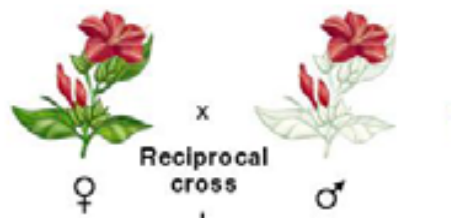


Inheritance of Leaf Variegation: *Mirabilis jalapa* (cross over result)



Result - **All white progeny**

2.



Result - **All green progeny**

- Variegated female plant gave rise to all three kinds of progeny i.e green, white and variegated irrespective of the phenotype of the male plant. Reciprocal cross confirmed the same.
- Correns discovered that seeds produced by flowers carried on the green branches gave progeny which were all normal green even if the phenotype of the donor pollen was green, white or variegated.
- Seed taken from white branches likewise gave all white progeny, regardless of the pollen donor phenotype.
- Seeds from flowers on variegated branches gave three kinds of progeny, green, white and variegated, in varying proportions; again regardless of the pollen donor phenotype.
- In other words, the phenotype of the progeny always resembled the female parent and the male made no contribution at all to the character.
- Even the reciprocal cross confirmed the same effect.

FEMALE (GREEN) X MALE (WHITE)



GREEN PROGENY

FEMALE (WHITE) X MALE (GREEN)



WHITE PROGENY

- The explanation for this unusual pattern of inheritance is that the genes concerned are located in the chloroplasts within the cytoplasm, not in the nucleus, and are therefore transmitted only through the female parent.
- In eukaryotic organisms the zygote normally receives the bulk of its cytoplasm from the egg cell and the male gamete contributes little more than a nucleus.
- Any genes contained in the cell organelles of the cytoplasm will therefore show **maternal inheritance**. The character is controlled by cytoplasmic genes located in the chloroplast 'chromosome'. Chloroplasts are self-replicating organelles and during sexual reproduction they are only transmitted through the cytoplasm of the egg cell, as undifferentiated protoplastids. They are not inherited through the pollen. The progeny of crosses therefore have the characters of the female parent and show maternal inheritance.
- This sort of pattern is known as **maternal inheritance**.