EXTRACHROMOSOMAL INHERITANCE

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INTRODUCTION

- Extra chromosomal inheritance defined as non-mendelian inheritance, usually involving DNA in replicating mitochondria and some other organelles of cell.
- Commonly defined as transmission through cytoplasm rather than nucleus.
- Inheritance due to genes located in cytoplasm (plasma genes)
- Plasma genes are located in DNA present in mitochondria and in chloroplast.
- Together both the DNAs are called organelle DNA.

EXTRANUCLEAR INHERITANCE IS OF THREE TYPES :

- Maternal inheritance
- Organellar inheritance
- Inheritance involving infectious particles

MATERNAL INHERITANCE

- character of only one of the two parents is transmitted to the progeny .
- In most animals, parental mitochondria enter the oocyte cytoplasm after fertilization their mt.dna is never transmitted to the offspring.

EXAMPLE : ***SHELL COILING IN SNAIL(Lymnea peregra)***

Two types of coiling pattern

Right handed (Dextral or clockwise)

Left handed (sinistral or anticlockwise)

Dextral coiling female

DD

Dextral coiling male

dd

All dextral

	D	d
D	DD	Dd
d	Dd	dd

Phenotypic ratio 3:1

IN RECIPROCAL CROSS:

Sinistral coiling female  Dextral coiling male

First generation : all sinisteral type

Other generation: 3 sinistral: 1 dextral

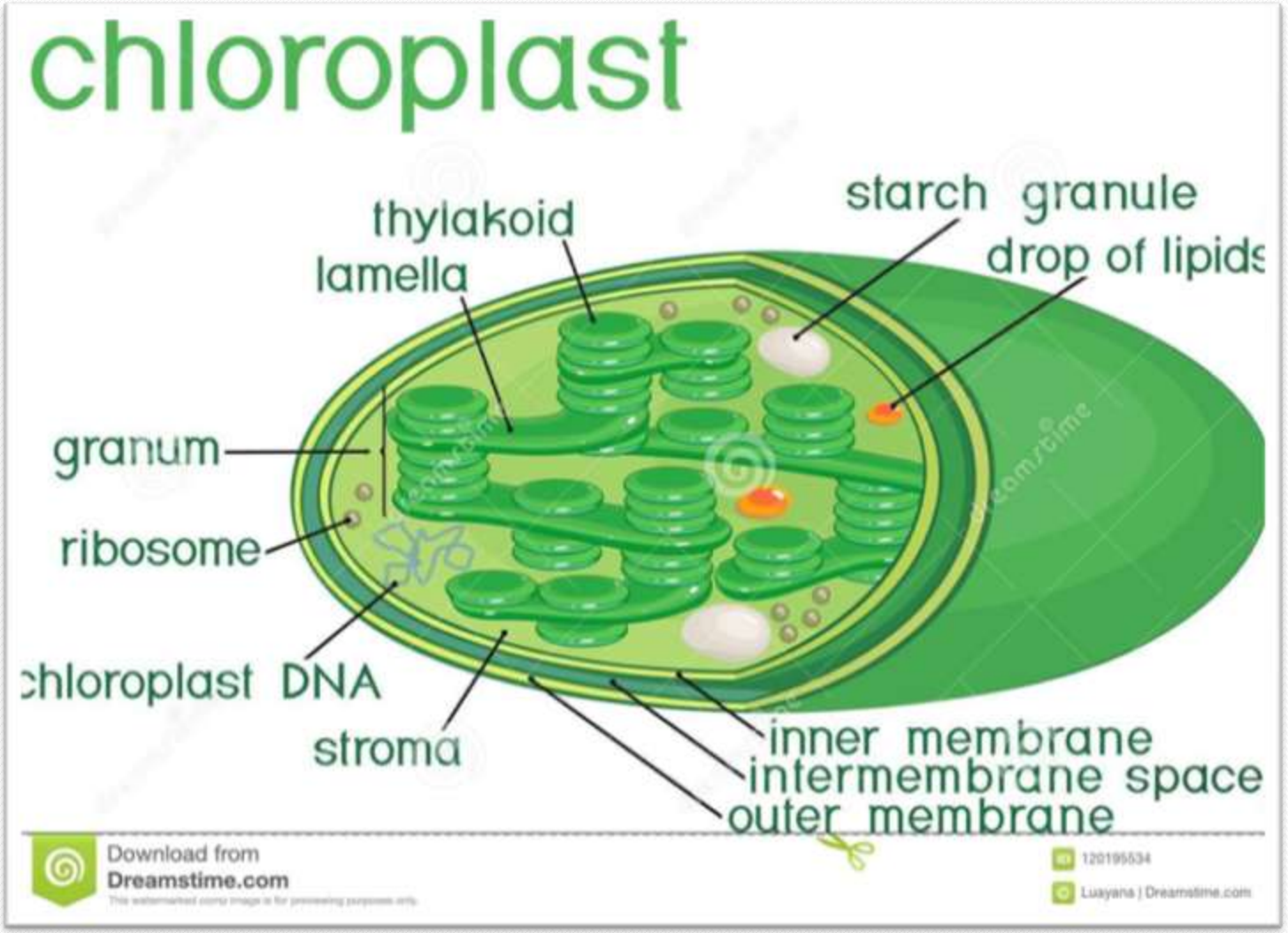
ORGANELLAR INHERITANCE

- CHLOROPLAST
- MITOCHONDRIA

CHLOROPLAST INHERITANCE

- Specialized organelle found in higher plants.
- Two membranes: outer and inner membrane.
- It possess internal membrane in the form of flattened sacs known as **thyllakoids**.
- They form stalk of disc at some places known as **grana.**
- Chloroplast has three parts:

- Envelope
- Matrix
- thyllakoids


chloroplast
thylakoid
lamella
starch granule
drop of lipids
granum
ribosome
chloroplast DNA
stroma
inner membrane
intermembrane space
outer membrane
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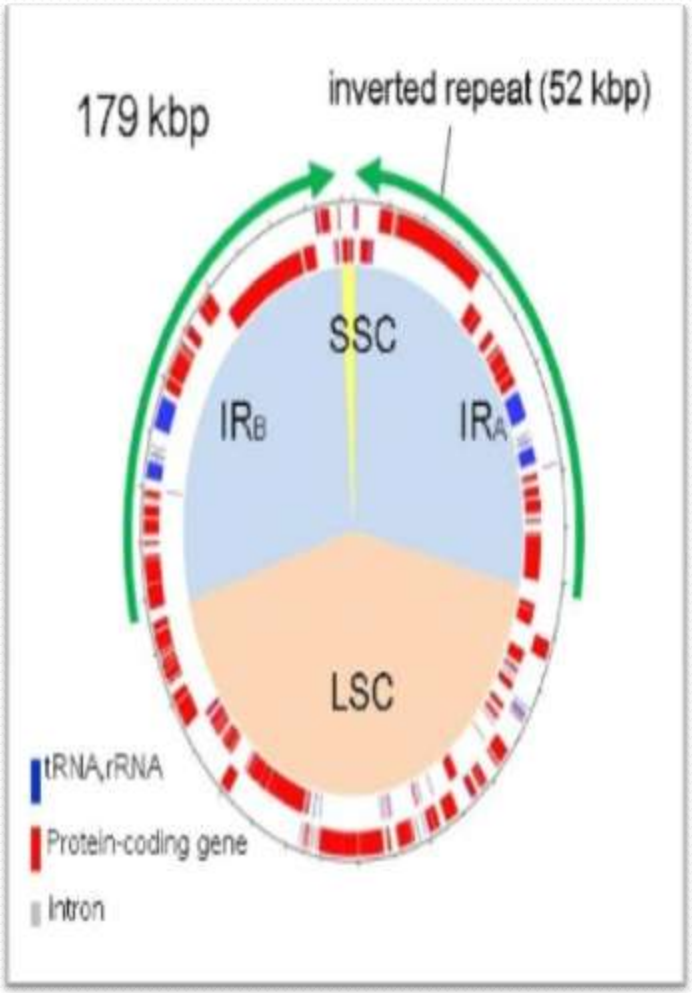
Functions

- ✓ Photosynthesis
- ✓Oxygen supply
- ✓Starch storage
- ✓Utilize carbondioxide
- ✓Synthesis of organic acid
- ✓Change into chromoplast
- ✓Food supply

GENOMIC STRUCTURE OF CHLOROPLAST DNA



- it resemble large bacterial plasmid or small chromosomes.
- cpDNA is closed circular ds molecule.
- **For example** in MAIZE there are about 50 copies of DNA per chloroplast.
- Single chloroplast contain information of 126 different protein molecule.
- The complete sequence of cpDNA found in ***liverworts and tobacco***.

Examples of cpDNA

IN Mirabilis jalapa

(a) female branch × male branch
(green) (variegated)

Green plants only

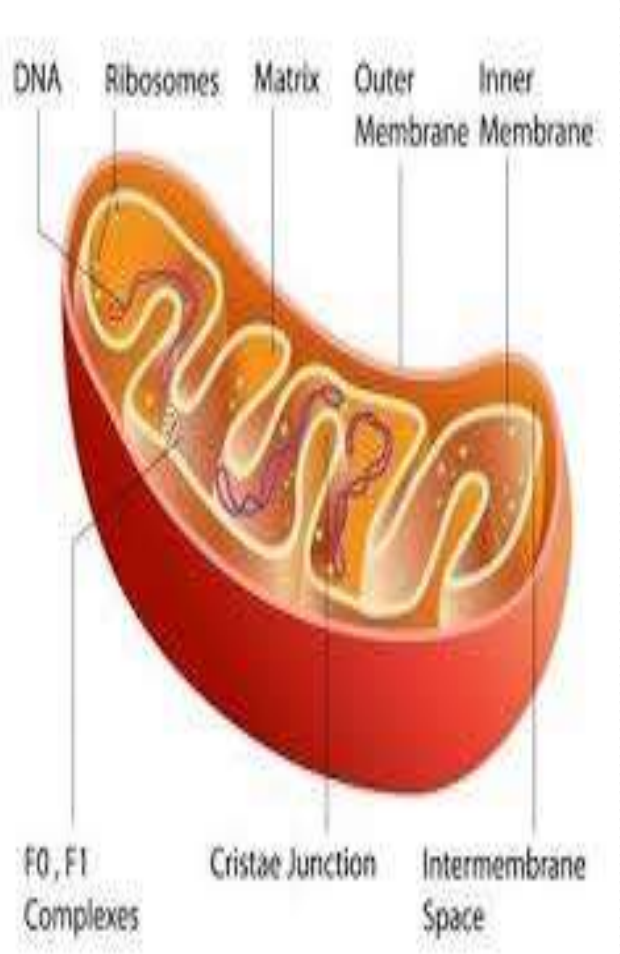
(b) female branch × male branch
(variegated) (green)

Variegated plants only

DISTINGUISHING FEATURES OF CHLOROPLAST AND NUCLEAR DNA

- cpDNA is circular while nuclear DNA is linear.
- Histone and other proteins are complexed with nuclear DNA but not with cpDNA.
- After denaturation cpDNA reassociate much more rapidly than nuclear DNA.
- cpDNA is smaller in size than nuclear DNA.
- Formation of **D loop**.

STRUCTURE OF MITOCHONDRIA



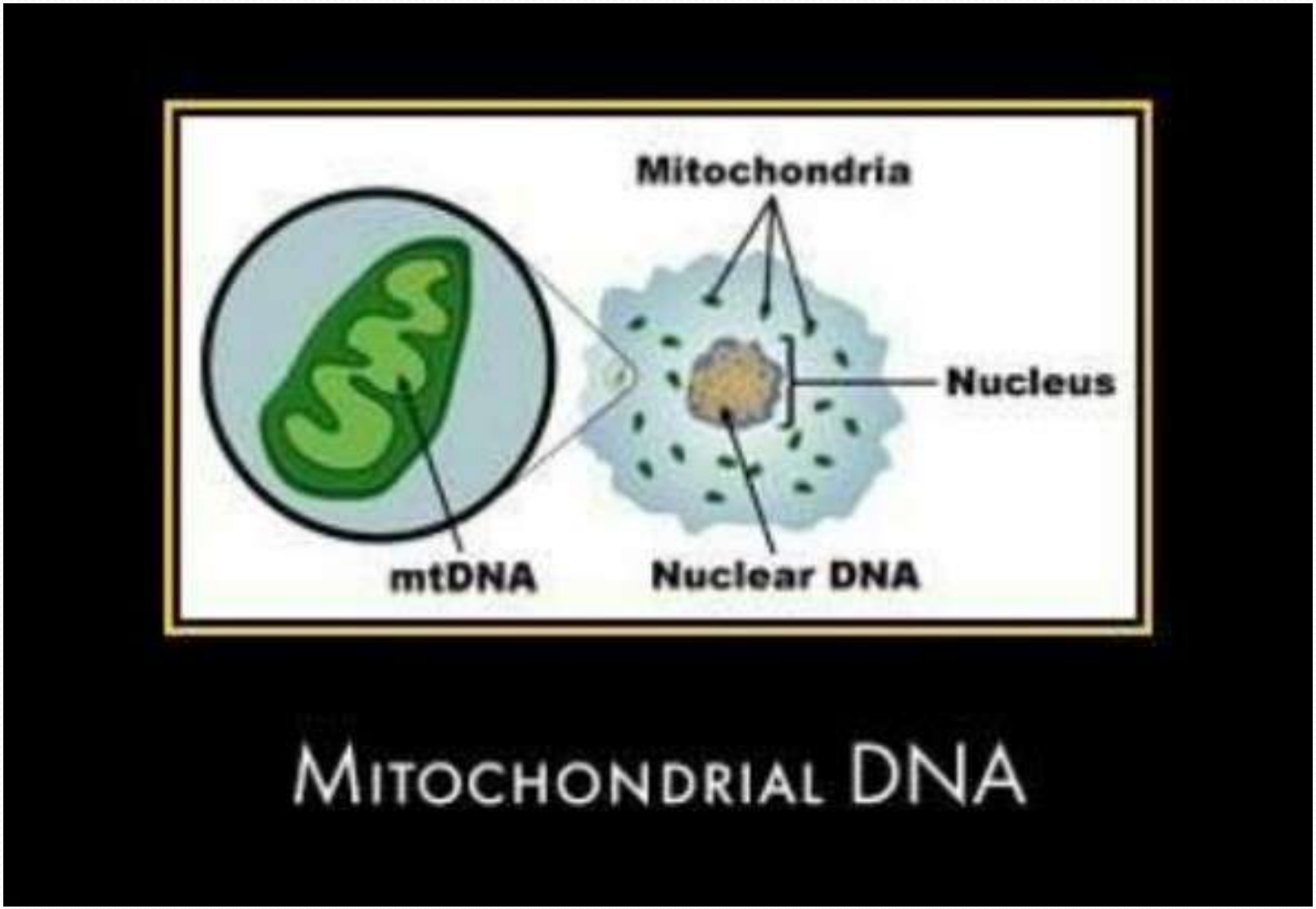
- Powerhouse of the cell.
- Position depends upon the requirement of energy and amino acid.
- it consist of three parts:
  - outer and inner membrane
  - Cristae
  - matrix

FUNCTIONS OF MITOCHONDRIA

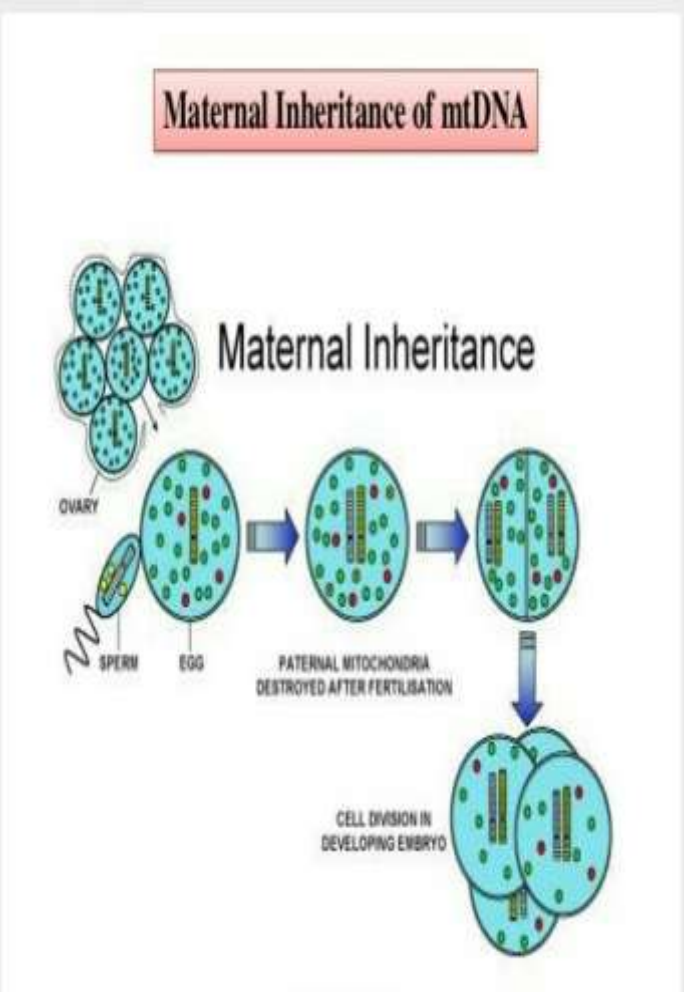
- Store and release calcium .
- Main seat of cell respiration.
- Synthesis of amino acid(glutamic and aspartic acid).
- Take part in maternal inheritance.
- Synthesis of several biochemicals like chlorophyll, cytochrome, alkaloid.

GENOMIC CHARACTER OF MITOCHONDRIAL DNA

- Mt.DNA is small genome
- it contain their own DNA which may be circular or linear.
- Haploid in nature
- Mt.DNA contain 37 genes and enclosed two types of rRNA and 22tRNA.
- G+C content of mt.DNA show variation from one sp. to another.
- **example:** 18% in **yeast** ,47%in **higher plants.**
- Two region: **coding region and central region .**


Mitochondria
Nucleus
mtDNA
Nuclear DNA
MITOCHONDRIAL DNA

MATERNAL INHERITANCE OF MITOCHONDRIAL DNA



- During fertilization, sperm only contribute its nucleus .
- mitochondria of the sperm cell are located at the mitochondrial sheath which is destroyed upon fertilization.
- Only available mt.DNA is that of the mother.

MITOCHONDRIA IN HUMAN DISEASE

1. **Laber's herediatary optic nuropathy (LHON)**

- Sudden onset of blindness in adult which is associated with death of optic nerve due to mutation in any of several mt.DNA.
- Net effect of these mutation has reductive efficiency of oxidative phosphorylation to such extent that the function of optic nerve is destroy which result in total blindness.
- LHON show only maternal transmission.

2. Pearson marrow- pancreas syndrome(PMPS)

- It is also caused by mt.DNA in this disease there is loss of bone marrow cell and this is fatal.
- Parents of person affected by the syndrome are almost normal. i.e. that mutation (deletion) in mt.DNA occurs either during oogenesis or during the development of fetous.

DISTINGUISHING FEATURES OF NUCLEAR DNA AND Mt.DNA

NUCLEAR DNA

- Found in nuclear of cell.
- Bounded by nuclear envelope.
- Two sets of 23 chromosome.
- Maternal and paternal inheritance.
- Double helix.
- DNA packed into chromatin.

MITOCHONDRIAL DNA

- Found in mt. of cell.
- No nuclear envelope.
- Several copies of the single mt. DNA.
- Maternal inheritance only.
- Circular.
- Not packed in chromatin.

CYTOPLASMIC MALE STERILITY

- Progeny from cytoplasmic male sterility and a normal male fertile strain and are all male sterile.
- it show cytoplasmic inheritance.
- As a result CMS strain has to be pollinated by male fertile strain in every generation for its maintainence.
- CMS is used in hybrid seed production in crops like **maize, jawar ,bajra** etc.

EVOLUTIONARY SIGNIFICANCE OF ORGANELLES

- The mitochondria and chloroplast once free living bacteria that form symbiotic relationships with the primitive eukaryotic cell more than one billion years ago is referred as **endosymbiotic theory.**

INHERITANCE INVOLVING INFECTIOUS PARTICLE

- Non mendelian inheritance is associated with infective particles like *parasite, viruses.*
- ***EXAMPLE: kappa particles in paramecium.***
- ***T.M. sonneborn*** *described the inheritance in* ***paramecium aurelia.***
- *There are two strains of paramecium :* ***killer and sensitive.***
- *Killer strain produce a toxic substance called* ***paramecin*** *that is lethal to other individual called* ***sensitive.***

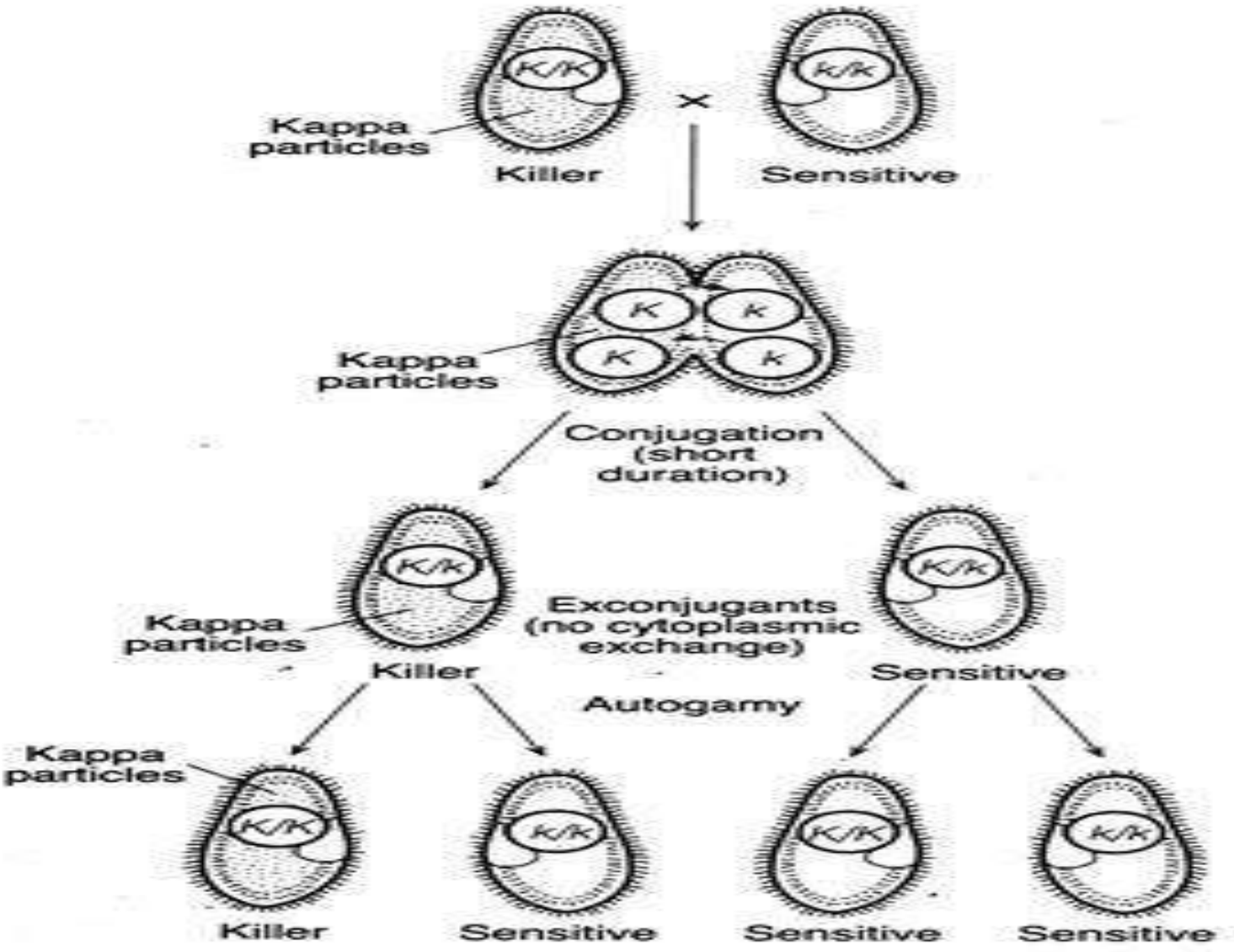


Fig. 10.9: Results of a cross between a killer (KK) and a sensitive (kk) strain of Paramoecium, when no cytoplasmic exchange is allowed (from Gupta)

SIGNIFICANCE OF EXTRANUCLEAR INHERITANCE

- ✓ Role of various cytoplasmic organelles in different organism.
- ✓ Mapping of chloroplast and mitochondrial in several species viz. *yeasts, maize, human etc.*
- ✓ Easily transfer to agronomic bases for their use in development of superior hybrids.
- ✓ Role of mitochondria in the menifestation of hetrosis.
- ✓ It leads to generation of new variants (ornamental plant).

THANKYOU