

Extrachromosomal and cytoplasmic inheritance

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Introduction of Extra Chromosomal Inheritance

- Extra Chromosomal Inheritance is defined as non mendelian inheritance, usually involving DNA in replicating mitochondria and some other organelles of cell.
- The genes that have been called cytoplasmic genes, extra chromosomal genes, or extra nuclear genes are located on a unique kind of chromosome inside cytoplasmic organelle.
- Commonly defined as transmission through the cytoplasm rather than the nucleus.

Rules of Extrachromosome Inheritance

Extranuclear genes display **Non-mendelian Inheritance**, which has four characteristics:

- a. Typical Mendelian ratios do not occur, because meiosis-based segregation is not involved.
- b. Reciprocal crosses usually show uniparental inheritance, with all progeny having the phenotype of one parent, generally the mother because the zygote receives nearly all of its cytoplasm (including organelles) from the ovum.
- c. Extranuclear genes cannot be mapped to chromosomes in the nucleus.
- d. If a nucleus with a different genotype is substituted, non-Mendelian inheritance is unaffected.

The main differences between cpDNA and the nuclear DNA are as follows -

1. About 10% of the cytosine residues are methylated as 5-methylcytosine
2. in nuclear DNA of higher plants ; such methylation is absent in cpDNA.
3. Chloroplast DNA is circular while nuclear DNA is linear.
4. Histones and other proteins are complexed with nuclear DNA but not
5. with cpDNA.
6. After denaturation, cpDNA reassociates much more rapidly than nuclear DNA.
7. Chloroplast DNA is smaller in size than nuclear DNA.
8. Replication of chloroplast DNA is accompanied by the formation of "displacement loops" (D-loops) that extend around the DNA circle. Such D-loop (s) are not formed during the replication of nuclear DNA. However, replication of both, cpDNA and nuclear DNA is semiconservative.



CYTOPLASMIC INHERITANCE



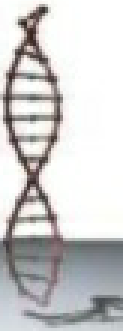
Cytoplasmic inheritance???

Extranuclear inheritance or cytoplasmic inheritance is the transmission of genes that occur outside the nucleus.

OR

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

Introduction



- *Mendelian inheritance patterns involve genes that directly influence the outcome of an organism's traits and Obey Mendel's laws.*
- *Most genes in eukaryotic species follow a Mendelian pattern of inheritance however, there are many that don't.*



Introduction

Additional pattern of inheritance that deviate from a Mendilian pattern include...

- Maternal effect & epigenetic inheritance.*
 - Involve genes in the nucleus.*
 - Extranuclear Inheritance*
 - Involve genes in organelles other than the nucleus.*
- 1. Mitochondria*
 - 2. Chloroplast*
 - 3. Plasmid*

Cytoplasmic Inheritance...



The acquisition of traits or conditions controlled by self-replicating substances within the cytoplasm, such as mitochondria or chloroplasts.

The phenomenon occurs in plants and some animals but has not been demonstrated in humans.

Maternal Inheritance:

Maternal inheritance - the female phenotype in a cross is always expressed in its offspring

Explanation:

- Is a result of the expression of a gene found in the genome of an organelle*
- For most species, all of the organelle DNA that is found in an embryo is from the female.*
- This is the biological basis of maternal inheritance.*

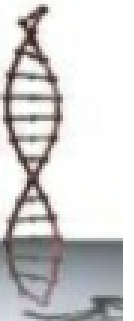
Infectious Heredity:

A parasite living in the cytoplasm is passed onto the offspring through the mother (maternal inheritance }

Cause=Sigma (A virus found in the cytoplasm.)



Organelle chromosomes:



A zygote inherits its organelles from the cytoplasm of the egg

Maternal Inheritance:

The patterns of inheritance is not associated with meiosis or mitosis because the organelles are in the cytoplasm not in the nucleus.

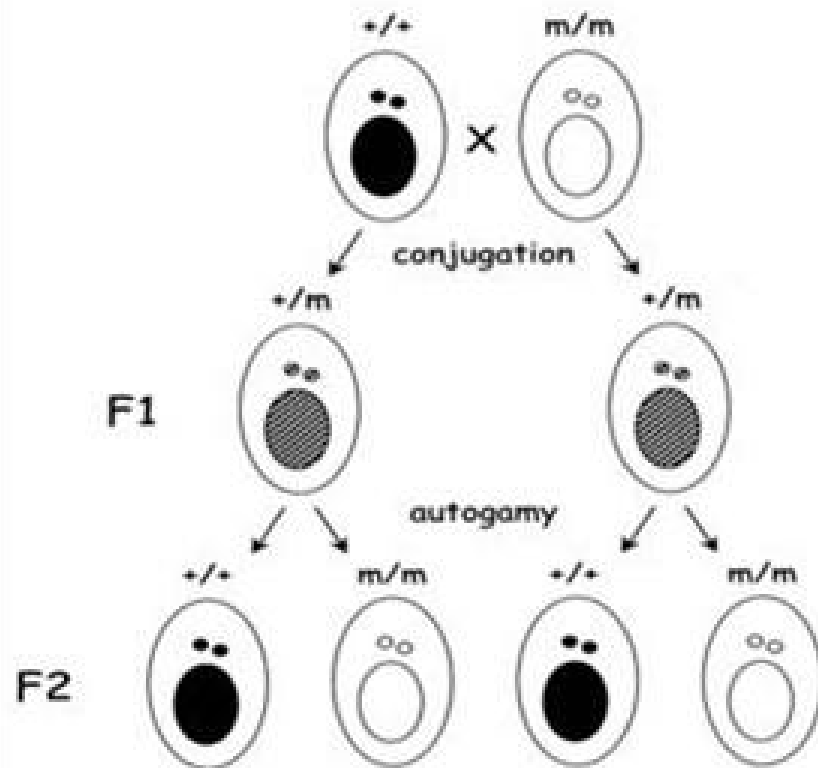
Organelles have circular chromosomes.

Inheritance Involving Infective Particles

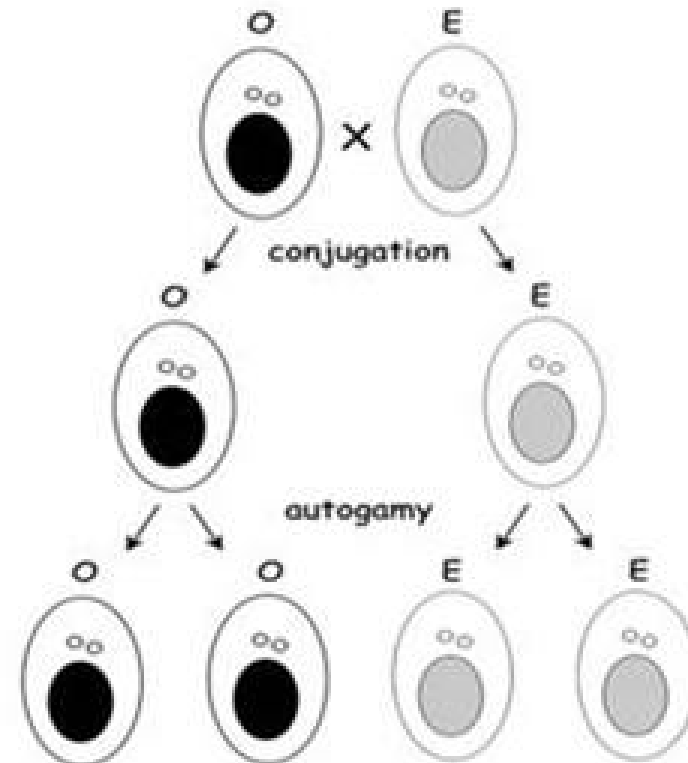
- In paramecin, killer strains contain cytoplasmic particles
- “Kappa particles” 0.4 μ m long contain their own DNA. Gene encodes paramecin toxin. Genes encode resistance to this toxin. Kappa particles are infectious. Particles in extract from killer strains can infect non-killer strains. Converted to killer strains.

Kappa particles inheritance

A. Mendelian segregation of a pair of alleles



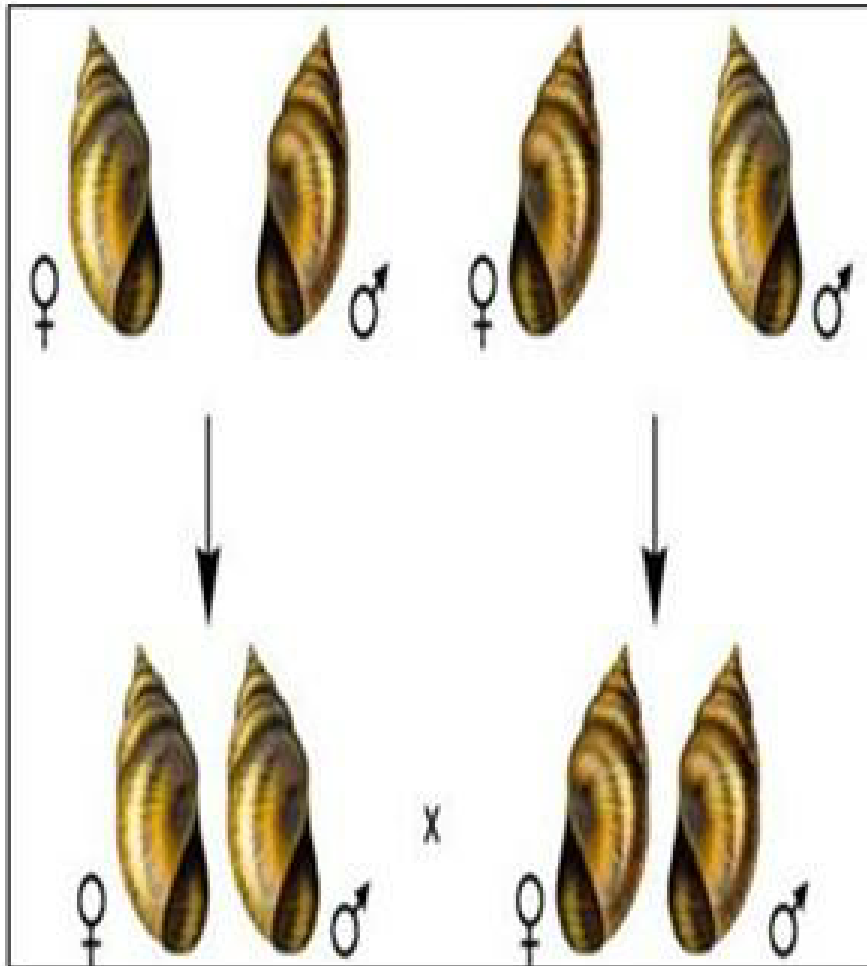
B. Maternal inheritance of mating types



A. E. Boycott (1920)

- First to study an example of maternal effect.
- Involved morphological features of water snail.
 - *Limnea peregra*
 - Shell and internal organs can be either right- or left-handed
 - Dextral or sinistral, respectively
 - Determined by cleavage pattern of egg after fertilization
 - Dextral orientation is more common and dominant.

Maternal effect in snail

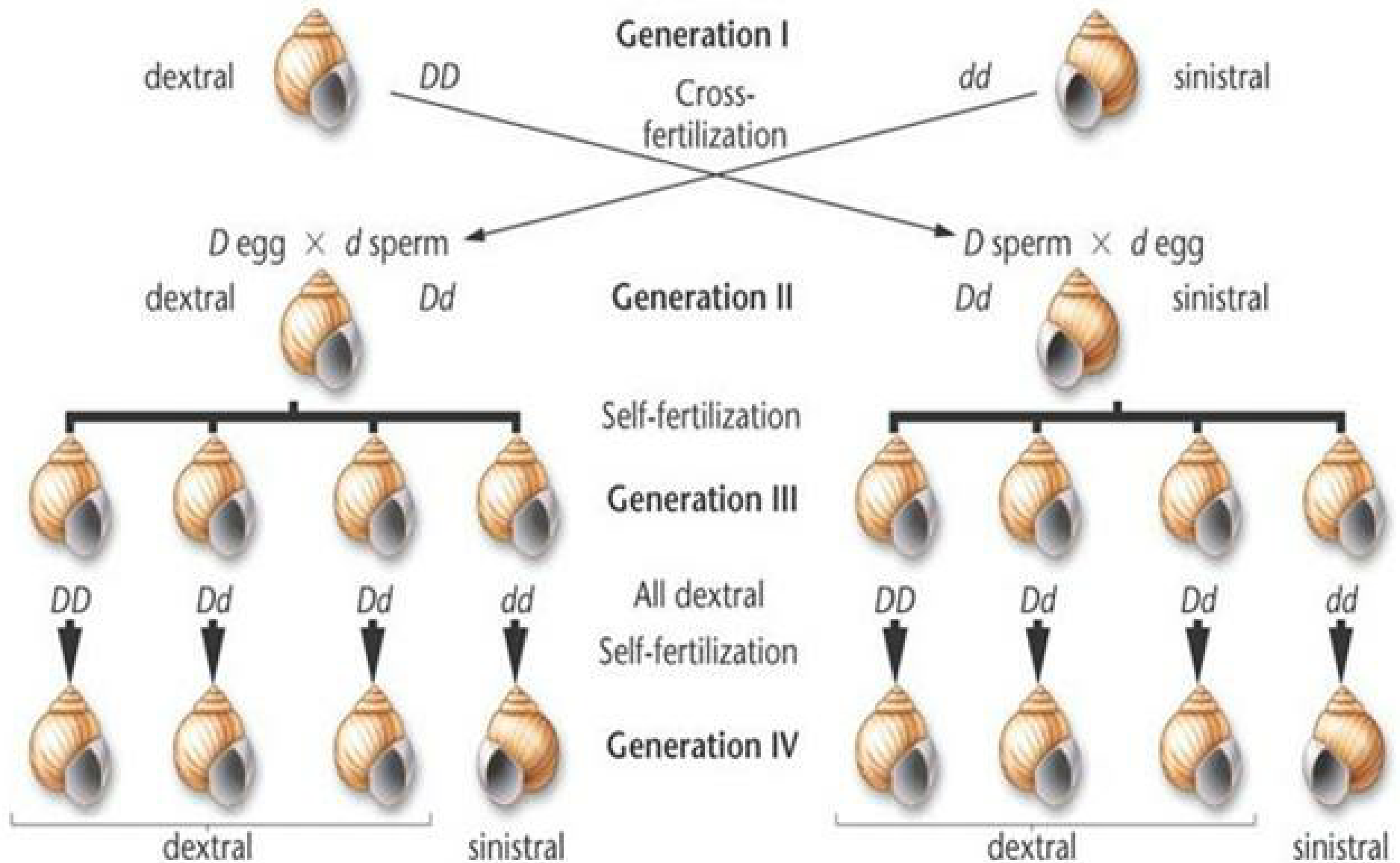


- -One dextral, one sinistral
- Dextral ♀ x sinistral ♂ → dextral offspring
- Reciprocal cross → sinistral offspring
- Contradict a Mendelian pattern of inheritance.

A. E. Boycott (1920) & Alfred Sturtevant (1923)

- Sturtevant proposed that Boycott's results could be explained by a maternal effect gene
 - Conclusions drawn from F_2 and F_3 generations
 - Dextral (D) is dominant to sinistral (d)
Phenotype of offspring is determined by genotype of mother.

Alfred Sturtevant (1923) result





6. Milk Factor in Mice

- **Bittner** reported a particular type of mammary cancer in mice susceptibility of which was maternally transmitted.
- Milk factor resembles in many respects with a virus.
- It has been discovered to be transmissible also by saliva and semen.



Thanks!

