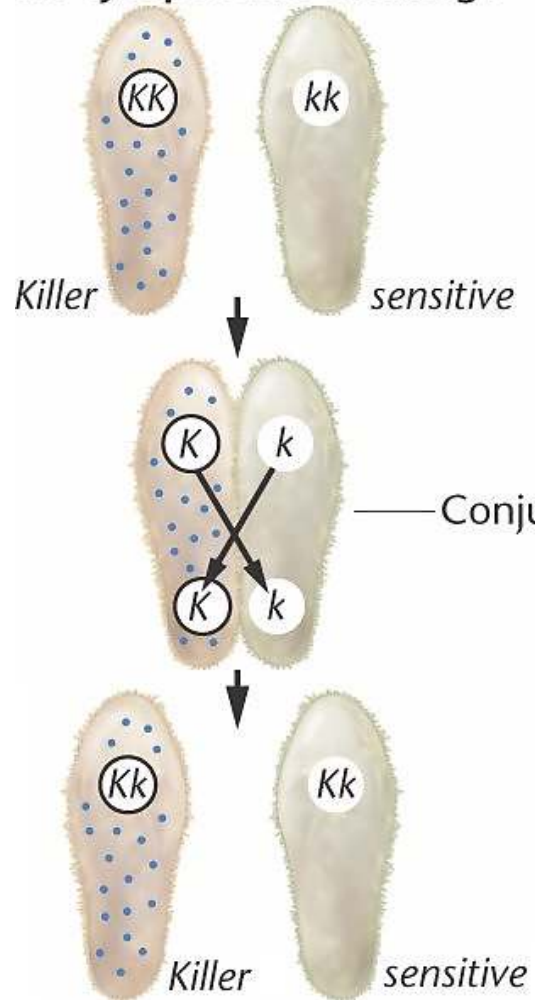
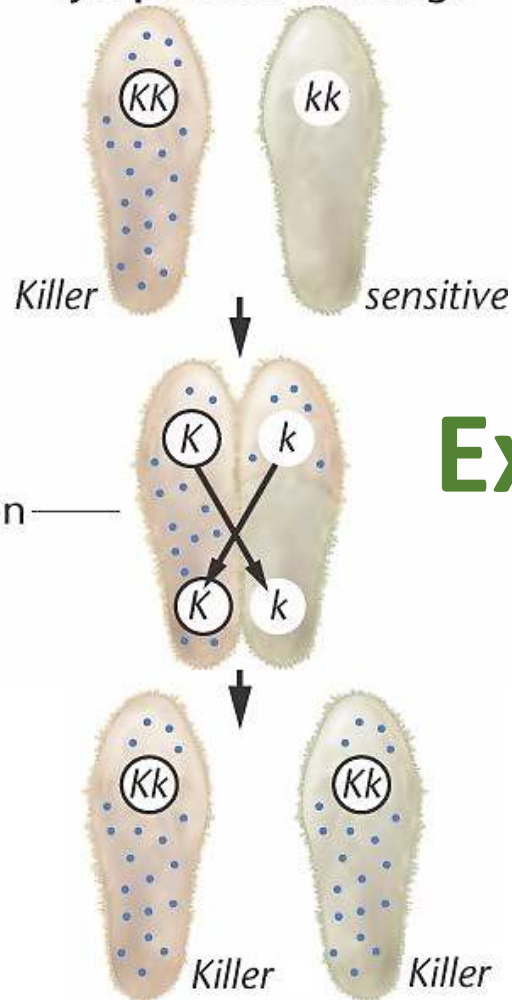


No cytoplasmic exchange



Cytoplasmic exchange

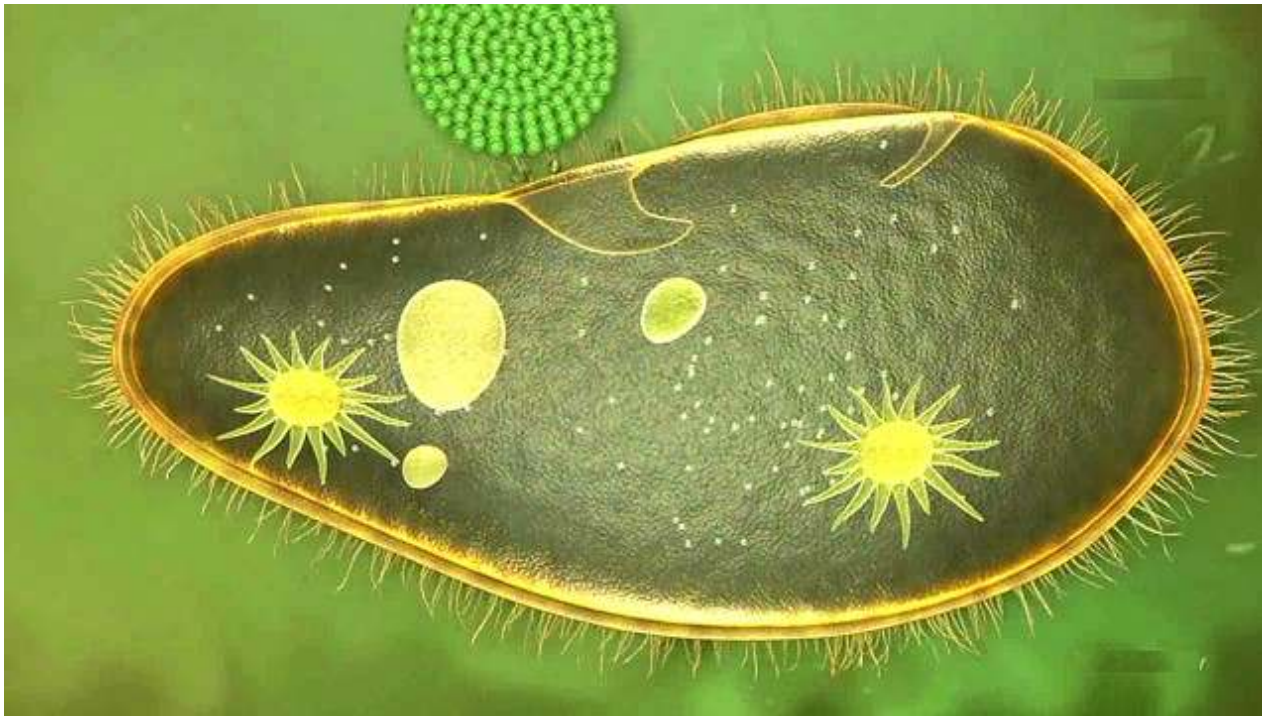


Extra Chromosomal Inheritance

What is extrachromosomal inheritance ?

- A **non-Mendelian pattern** of inheritance governed by the **cytoplasm** (the cytoplasm also carries **hereditary determinants**) is known as extrachromosomal inheritance or cytoplasmic inheritance.
- It was first reported by **Boris Ephrussi in yeast** during 1949.
- Determinants of this kind of inheritance are **not located in the chromosome** but may be **found in any other cell component** (for example, even in the **karyoplasm**) .
- Cytoplasmic DNA or extrachromosomal DNA is present significantly in some important organelles like **chloroplast and mitochondria**.
- The extrachromosomal DNA inherited **from the maternal side**.
- Hereditary determinants occurring **outside of the chromosomes** have the **capacity of self-replication and can be transmitted sexually or asexually**.
- The extrachromosomal hereditary factors are subdivided into the **Plastome (factors in the plastids)** and the **Plasmone (factors in the remainder of the cytoplasm)**.

Kappa particle in *Paramecium*



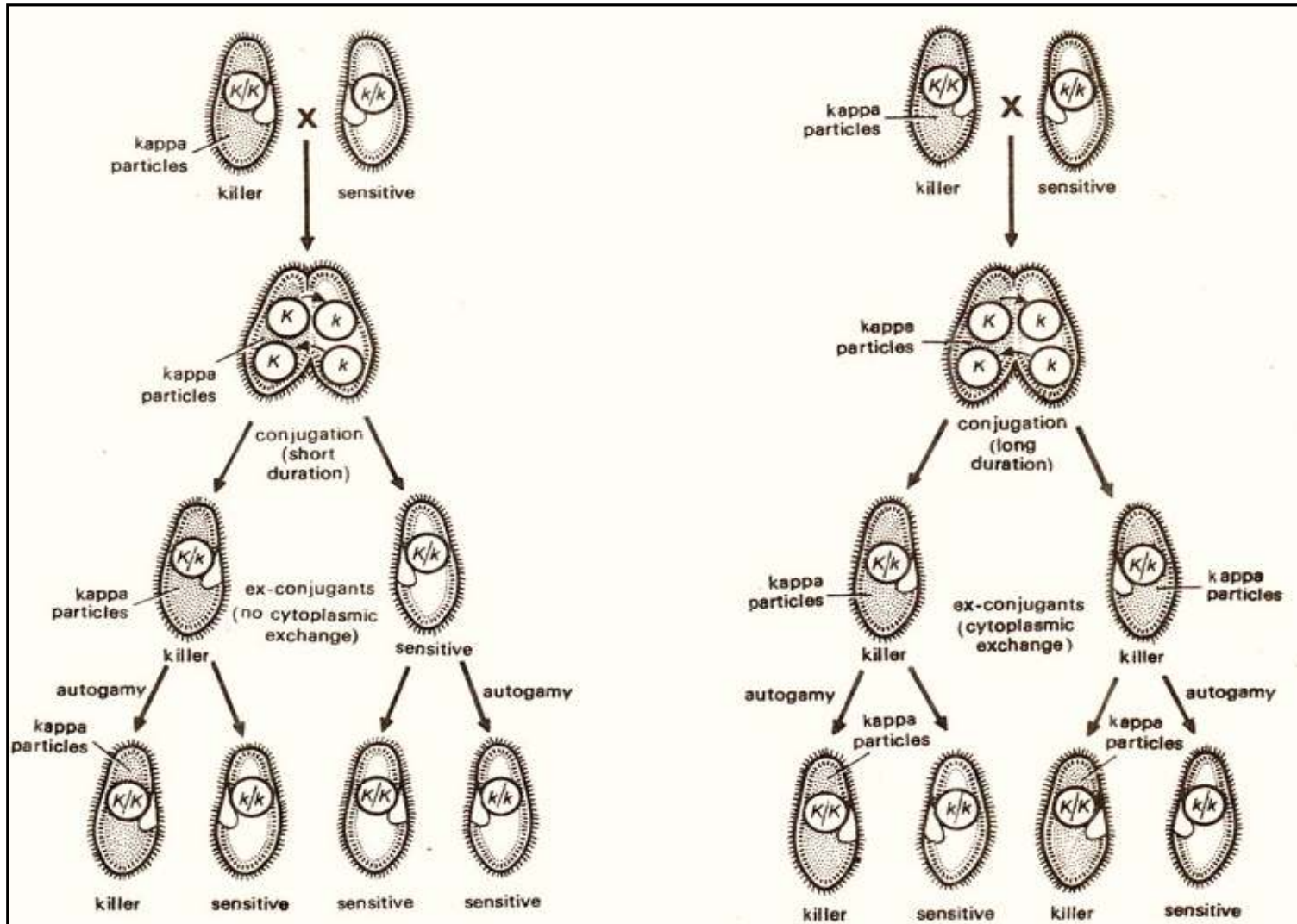
Kappa particle in *Paramecium*

Subhadipa 2021

- Kappa particles are found in certain **killer strains of *Paramecium*** and are responsible for production of substance **paramecin**, which is **toxic to strains not possessing kappa (sensitive strain)**.
- Upon ingestion this substance is believed to break down the food vacuole membrane of sensitive cells.
- The production of kappa particles is **dependent on a dominant allele K present in nucleus**, so that **killer strains are KK or Kk and sensitive strains are ordinarily kk**. However, 'K' cannot initiate the production of kappa in the total absence of kappa in the cytoplasm.
- In absence of dominant allele K, kappa particles cannot multiply and in absence of kappa particles, dominant allele K cannot produce them de novo.
- Consequently **sensitive strains with genotypes KK or kk** can be obtained.
- These will not carry any kappa particles. However, killer strain with genotype kk cannot be obtained, because even if kappa particles are present, these would be lost in absence of dominant allele.
- When **kappa is removed from killer cells by high temperature or X-rays**, these cells become sensitive.
- The kappa particles are **transmitted through the cytoplasm**.

Results of a cross between a killer (KK) and a sensitive (kk) strain of *Paramecium*

- If **conjugation** is **normal**, i.e., lasts only for a **short time**, and **no exchange of cytoplasm** takes place between the two, **both killers and non-killers (sensitive) are produced**.
- However in **rare or prolonged conjugation** (i.e., lasting for **long time**) the cytoplasmic bridge between the two conjugants is larger. In such cases, **in addition to the nuclear material, the cytoplasmic materials are also exchanged**. During this cytoplasmic exchange, the **kappa particles present in the cytoplasm of the killer type enter the non-killer type and convert it into a killer type**. So all the offspring produced by the exconjugants are killer type.



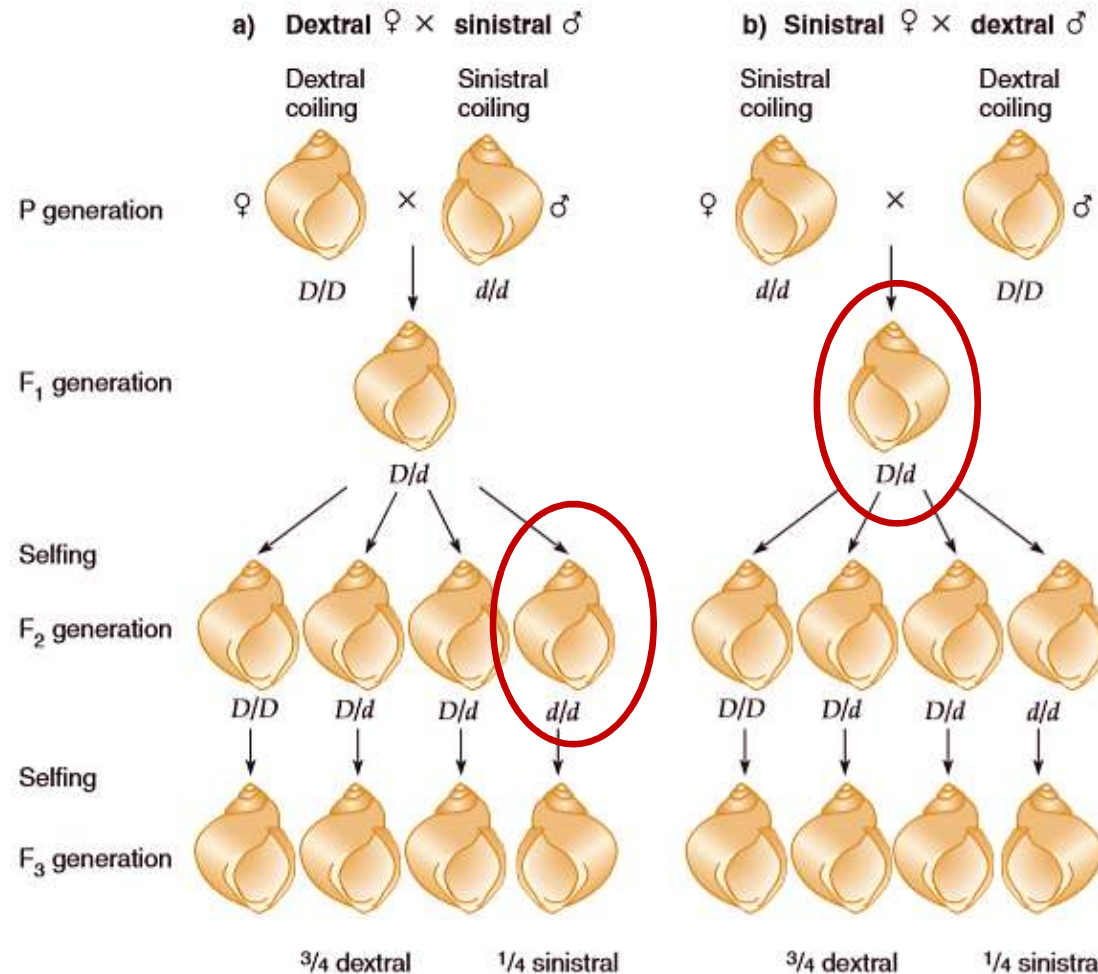
Shell Coiling: Maternal Effect



Shell coiling in Snail

- Maternal effect is the phenomenon in which a **phenotype of the offspring is determined not by the genotype** of the offspring but by the **nuclear genotype of the mother**, with no influence by the paternal nuclear genome.
- Maternal effect occurs as the **result of mRNA or proteins deposited in the oocyte before fertilization that direct early development of the embryo.**
- The genes that **encode those products are known as maternal effect genes.**
- Maternal effect is seen in the inheritance of the coiling direction in the shell of the **snail *Limnaea peregra*.**
- The shell coiling trait is **determined by a single pair of nuclear alleles:** the **dominant D allele for coiling to the right (dextral coiling) and the recessive d allele for coiling to the left (sinistral coiling).**
- The shell coiling phenotype is always determined by the genotype of the mother.

Reciprocal crosses between a true-breeding, dextral-coiling and a sinistral coiling snail

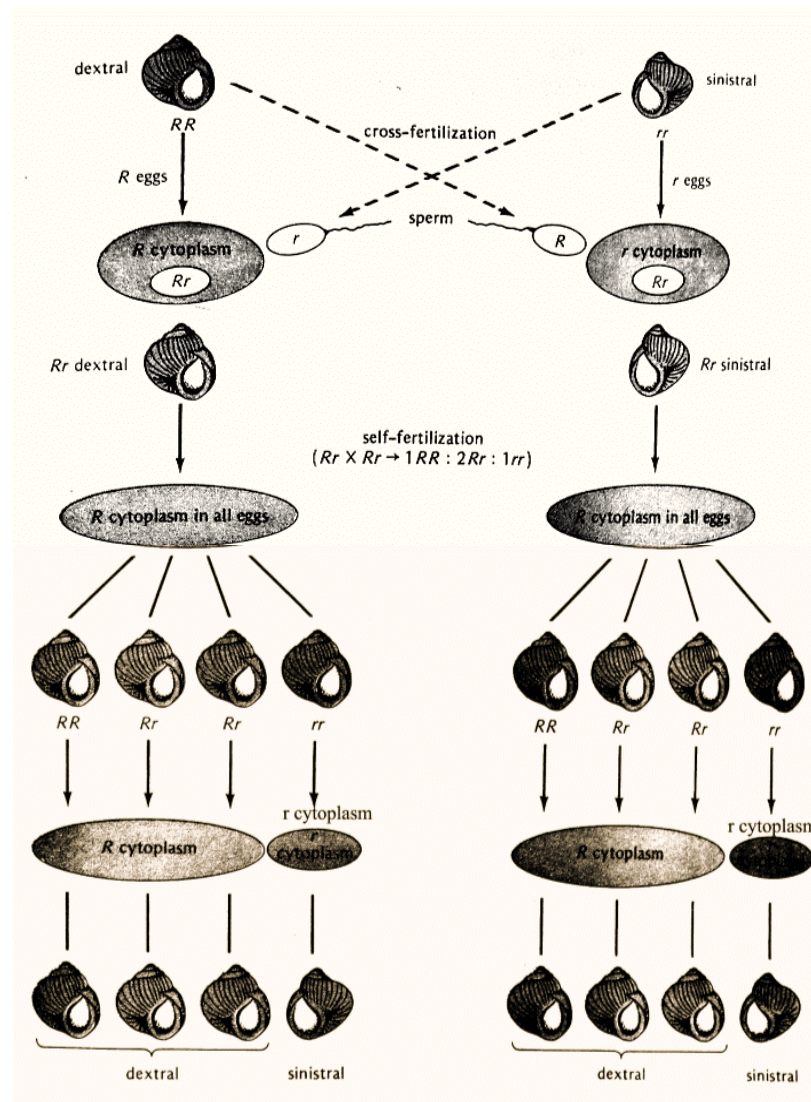


The F₁ snails are all D/d in genotype, yet they are sinistral in phenotype because the mother is genotypically d/d .

Maternal effect; the d/d snails have a coiling phenotype specified not by their own genotype, but by the genotype of their mother (D/d).

What is the basis for the coiling?

- The orientation of the mitotic spindle in the first mitotic division after fertilization controls the direction of coiling.
- The mother encodes products, deposited in the oocyte, that direct the orientation of the mitotic spindle and therefore the direction of cell cleavage.
- Thus, a mother of genotype D/– deposits a gene product that specify a dextral coiling.
- A mother of genotype d/d either does not produce a gene product, or that product is nonfunctional, and this results in default sinistral coiling.



From
Strickberger