ZOOA-CC5-12-TH

Unit 5: Extra-chromosomal Inheritance

KAPPA PARTICLES IN *Paramecium*

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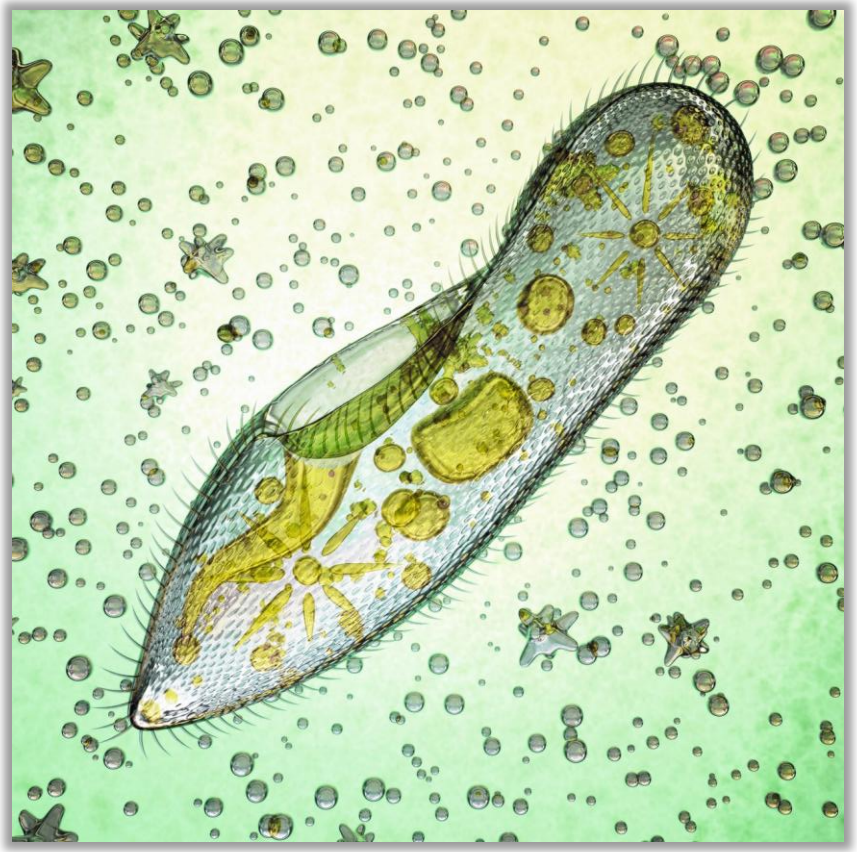
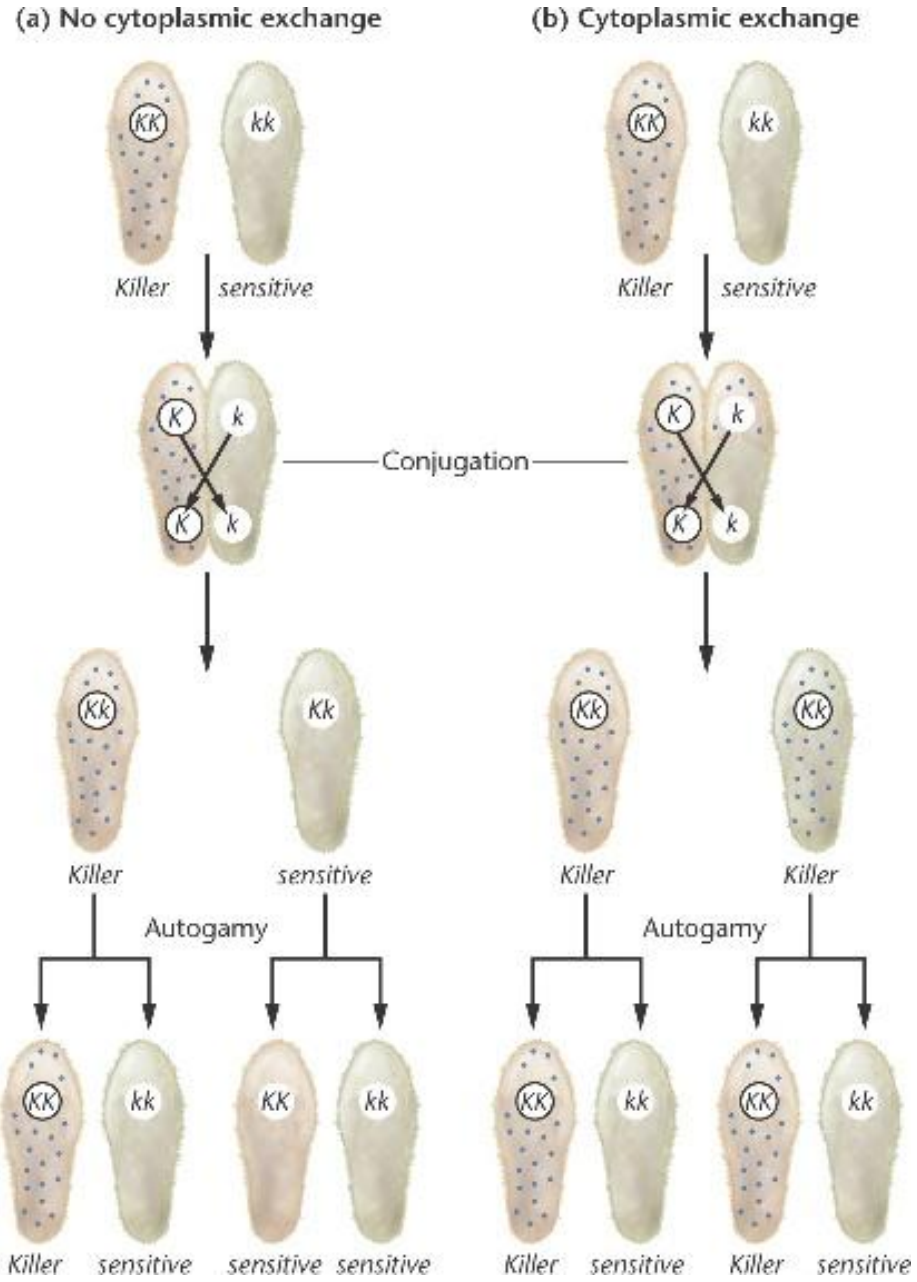




CYTOPLASMIC INHERITANCE

- Extra chromosomal inheritance is defined as non mendelian inheritance.
- It was first reported by Boris Ephrussi in yeast during 1949.
- All inherited characters are not determined by genes located in the nucleus.
- Some self replicating genes (DNA) are present in the cytoplasm (**mitochondrial DNA** and **chloroplast DNA**) known as *plasmagenes* or *cytogenes* or *plasmids* or *plasmons* etc.
- The inheritance of characters by plasmagenes is called *Non-mendelian* or *Extra-chromosomal* or *Cytoplasmic* or *Extra-nuclear inheritance*.
- Since they are *extrachromosomal* (outside the chromosomes), such genes are not subject to the normal rules of Mendelian heredity.
- In most organisms, the organelles pass through the egg and not the sperm, giving a strict *maternal pattern of inheritance* for any mutations that may be present in the organelle DNA.

- In cytoplasmic inheritance, the results of reciprocal crosses are not the same.

Some cytoplasmic inheritance:-

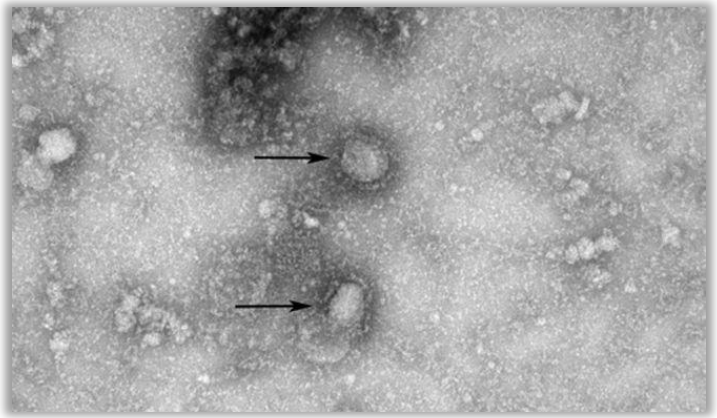
- Plastid inheritance in *Mirabilis*
- Shell coiling in snail
- Kappa particles in *Paramecium*
- Cytoplasmic male sterility in maize
- Sigma virus in *Drosophila melanogaster*

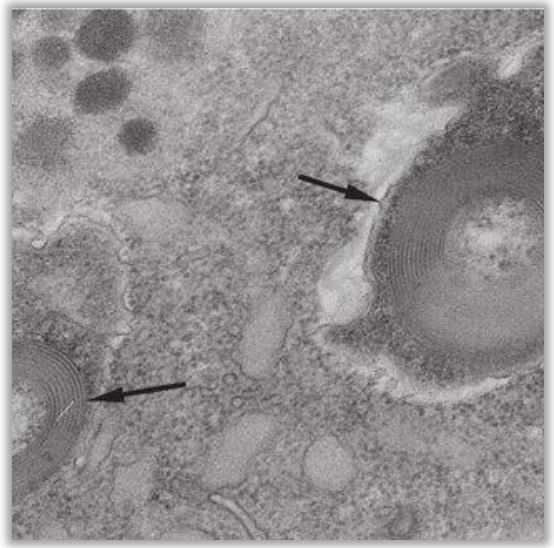
Maternal inheritance

- The determination of the phenotype of offspring by the genotype of female parent is called *maternal inheritance* or *uniparental inheritance or maternal effect*.
- Pattern of shell coiling in snail
  - Here the shell coiling is determined by the genotype of the mother and not by the individual's own genotype.

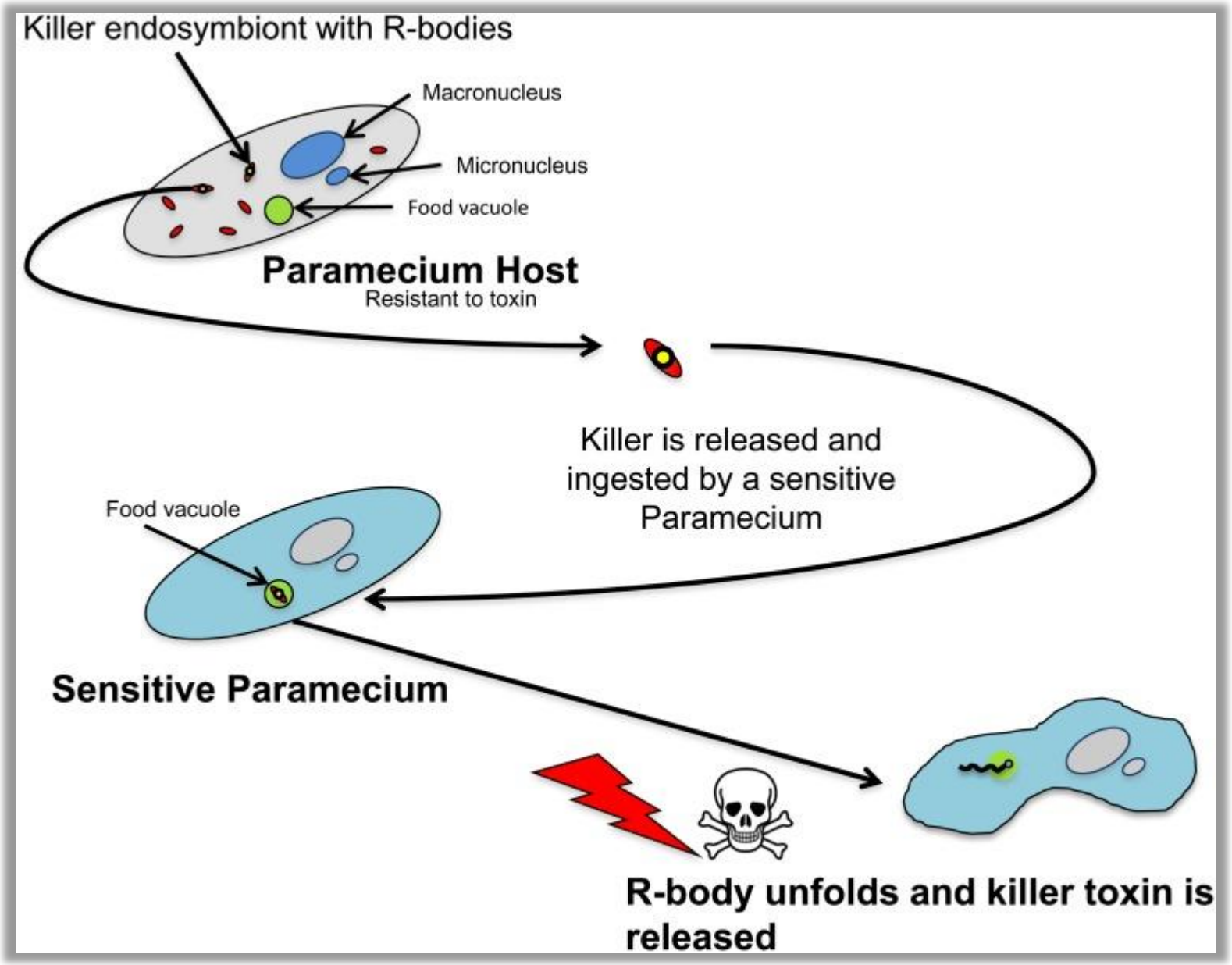
KAPPA PARTICLES IN *Paramecium*

- **Inheritance of Kappa Particles in *Paramecium*** was reported by T. M. Sonneborn in 1943.
- Kappa particles are the **bacteria** that are symbiont in nature, called ***Caedobacter taeniospiralis.***
- The diameter of the kappa particles is about 0.2µ.
- These bacteria possess refractile protein, which contains 'R' body and are called **brights** because the bacteria are infected with a virus that monitors the implication of viral protein and **R protein** body in kappa bacterium. R body facilitates the entry of the toxin.
- Kappa particles secrete a toxic substance, **paramecin.** (It is believed to breakdown the food vacuole membrane of the sensitive strain). It is diffusible in the liquid medium.
- The kappa particles are transmitted through the cytoplasm.

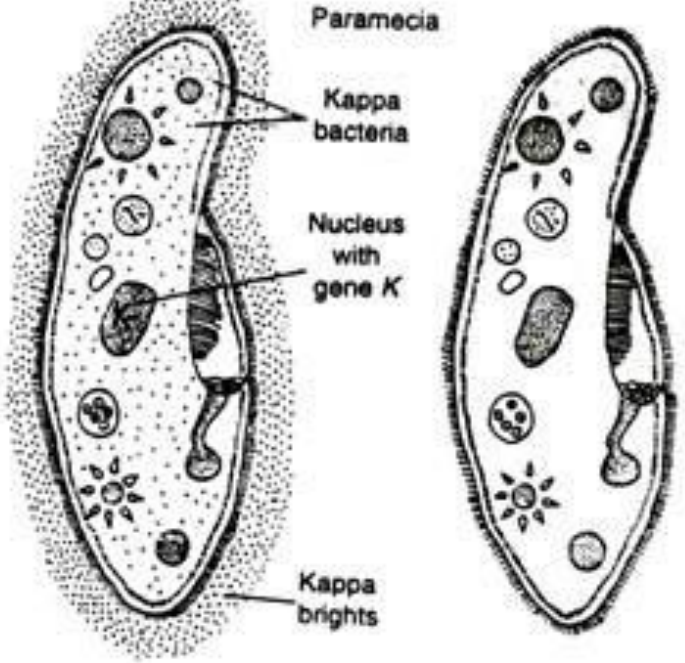




Kappa Particle, gram-negative symbiotic bacterium found in the cytoplasm of certain strains of the protozoan *Paramecium aurelia*. These bacteria, when released into the surroundings, change to P **particles that secrete a poison (paramecin) that kills other sensitive strains of *P. aurelia*.**



- There are two strains of *Paramecium*, killer strain and sensitive strain.
- **Killer strain** of *Paramecium aurelia* contain kappa particles**.**
- The *Paramecium* strain in which the kappa particles are not present, known as **Sensitive strain.**
- The sensitive strain is killed by the killer strain. When killer strains are allowed to remain in a medium for some time, they are not killed. The secretion paramecin is harmless to the killer strains.



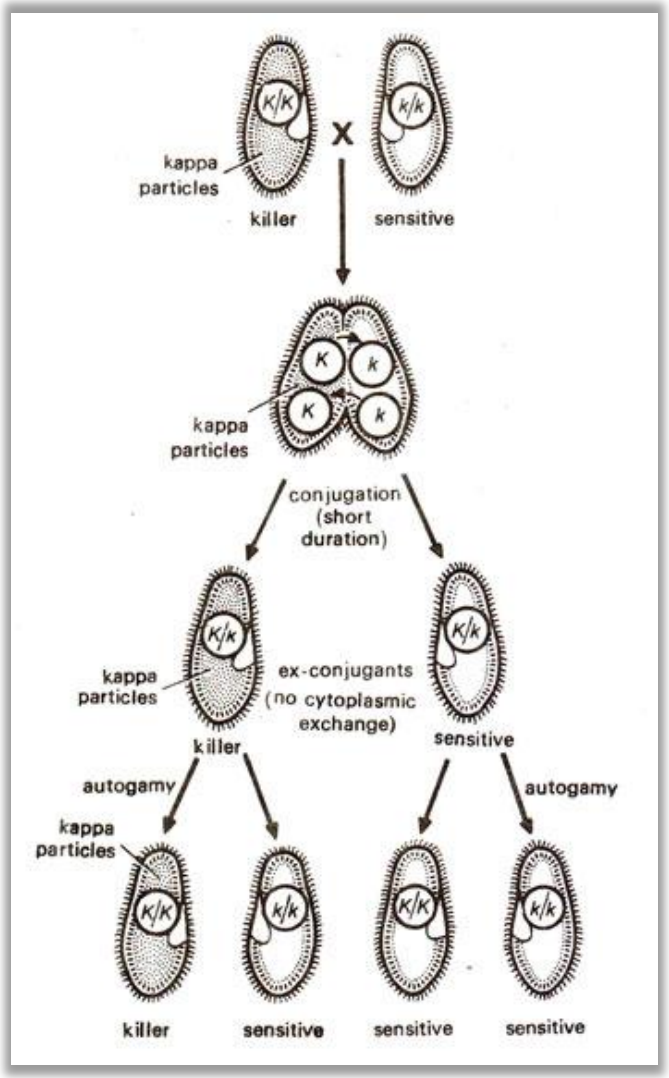
(a) Killer strain Paramoecium with Kappa particles and nucleus with gene K; (b) Sensitive Paramoecium with no Kappa particles and nucleus with gene k.

- The production of kappa particles is dependent on a dominant allele *K,* so that killer strain contains genotype ***KK*** or ***Kk***, and sensitive strains contain ***kk***.
- **In the** absence of dominant allele *K*, **kappa particles cannot multiply**, and in the absence of kappa particles, dominant allele *K* cannot reproduce them.

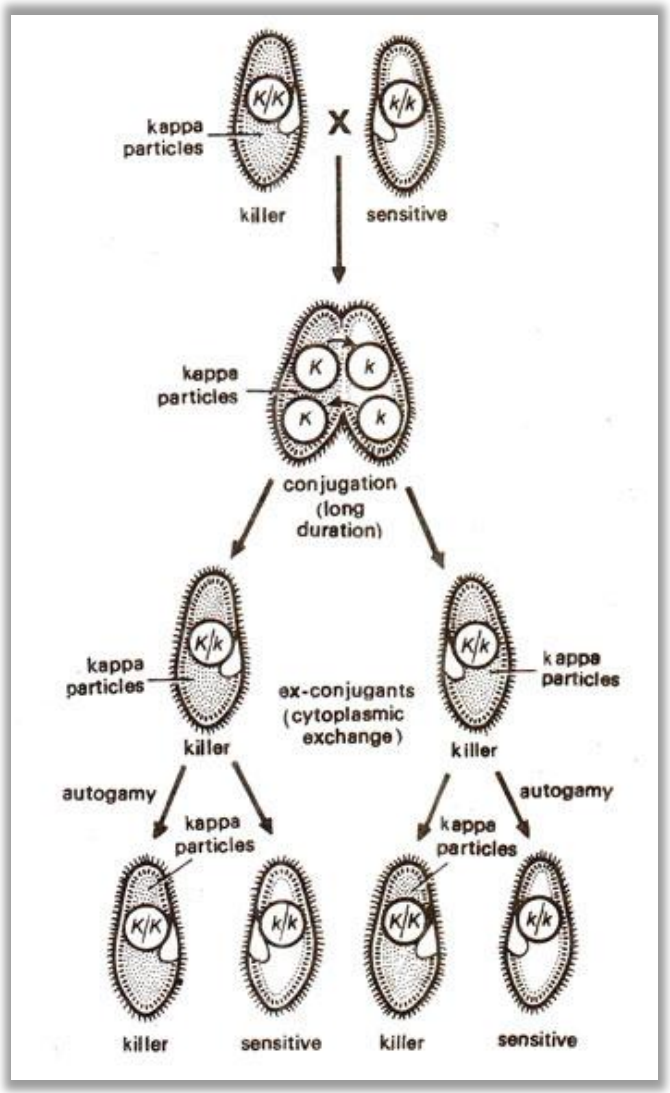
- Multiplication of the kappa particles is controlled by a dominant gene(*K*) of the *P. aurelia*.
- Autogamy in heterozygous (Kk) produces **KK** and **kk** segregants in the ratio 1:1. The recessive (kk) individuals are not able to support the multiplication of kappa particles.
- The progeny obtained (after autogamy) in killer (KK) and sensitive (kk) mating become sensitive after 10-15 divisions. The dominant *K* gene does not produce the kappa particles; it enables the multiplication of kappa particles if they are present in such a (Kk) animals.
- When a *Paramecium* of killer strain is having the genotype "KK" or (K+) conjugates with the *Paramecium* of non-killer strain having the genotype "kk", the **exconjugants are all heterozygous for "Kk" genes**.

- The development of a particular type depends upon the duration of cytoplasmic exchange
- If conjugation is normal (lasts only for a short time) only **change of haploid nuclei** and **no exchange of cytoplasm** takes place between the two, both killers and non-killers (sensitive) are produced.

- In rare or prolonged conjugation (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. The killer character shows a **cytoplasmic inheritance pattern**.

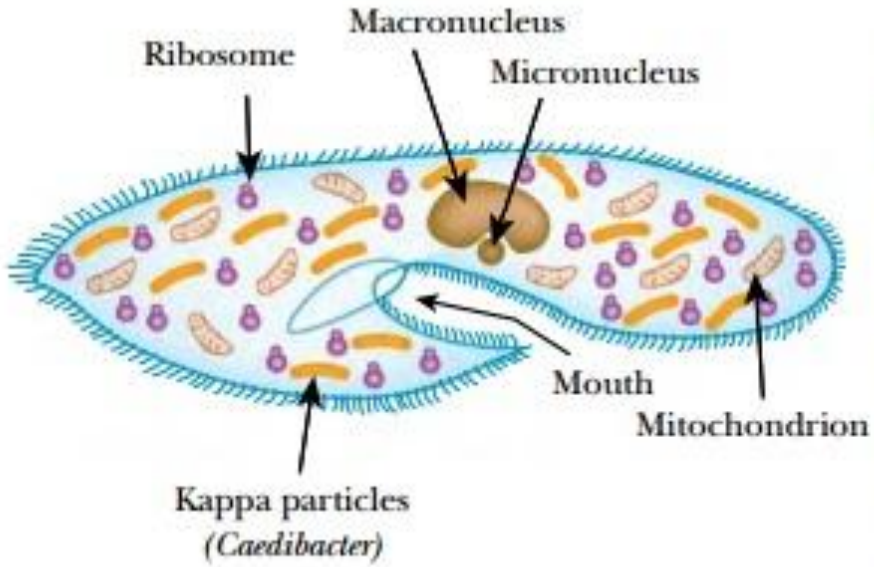


Results of a cross between a killer (KK) and a sensitive (kk) strain of *Paramecium*, when **no cytoplasmic exchange is allowed** (Short duration)



Results of a cross between a killer (KK) and a sensitive (kk) strain of *Paramecium*, when **cytoplasmic exchange is allowed** (Long duration)

A) KILLER *PARAMECIUM* CONTAINS *CAEDIBACTER*



B) KAPPA PARTICLES DIVIDE INSIDE *PARAMECIUM*

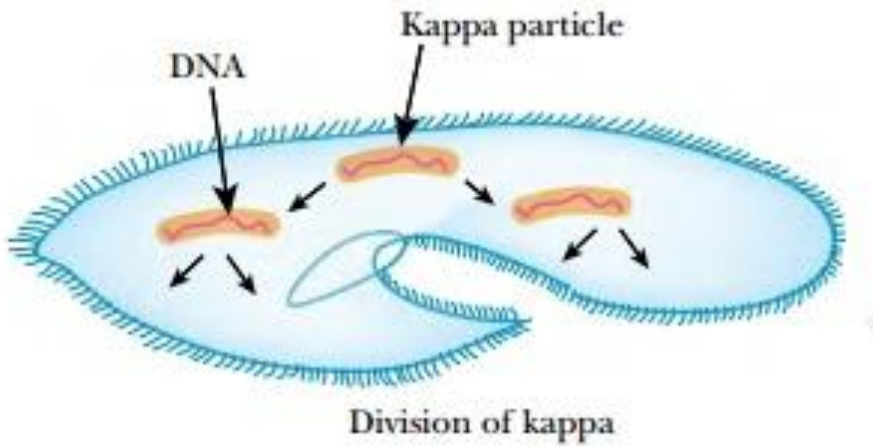


FIGURE 23.1 Killer *Paramecium* Uses a Bacterial Toxin
(A) The kappa particles are found in the cytoplasm of the *Paramecium*. (B) Kappa particles are symbiotic *Caedibacter* that are found in many strains of *Paramecium*, yet they have their own DNA and divide like typical bacteria.