Maternal Inheritance

Maternal inheritance:

Inheritance that deals with the inheritance of extra-nuclear DNA. Mitochondria, Chloroplasts, and other cytoplasmic factors such as kappa particle in *Paramecium* are transmitted directly from one generation to other, often through the cytoplasm and not through the nucleus.

Inheritance of kappa particle

Tracy Sonneborn discovered the killer trait in *Paramecium.* In *Paramecium aurelia,* there are two micronuclei, which are primarily reproductive nuclei, and one macronucleus, which is a polyploid concerned with the vegetative functions of the cell. *Paramecium* undergoes two types of nuclear rearrangements, **conjugation** and **autogamy.** In conjugation, individuals of two mating types come together and form a connecting bridge, called cytoplasmic bridge. Depending on the period of conjugating time, an exchange of cytoplasm may occur along with the exchange of nuclei.

T. M. Sonneborn and his colleagues found a persistent extranuclear effect in *Paramecium*. Some strains of *P. aurelia* produce a substance having lethal effect on the members of the other strains of the same species. Paramecia from strains capable of producing the toxic substance are called "killers". When killers are subjected to low temperatures, their killing capacity gradually vanishes. The toxic effect also decreases after repeated cell divisions. About **400** killers are required for making a killer effective. Killers are then observed under microscope and are called "Kappa". The kappa particles are shown to be symbiotic bacteria named ***Caedobacter taeniospiralis*** , i.e. killer bacterium with spiral ribbon.

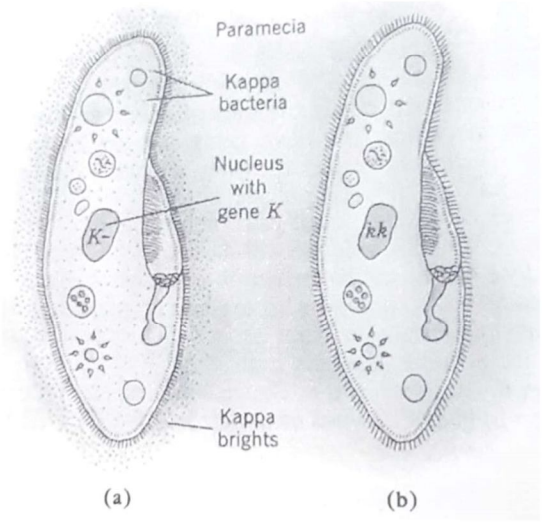
A toxic substance (paramecein) produced by the killer bacteria is diffusible in fluid medium. When killers are allowed to remain in a medium for a time and are then replaced by sensitives, the sensitives are killed. Paramecin has no effect on killers. These kappa bacteria possess a refractile protein-containing "R" body and are called "**brights**" because they are infected with a virus that controls the synthesis of viral protein. The virus is toxic to sensitive paramecia but is non-toxic to nonbright bacteria. Kappa bacteria are perpetuated in organisms carrying dominant nuclear allele K, which establishes the environment necessary for the bacteria to reproduce. When killer conjugates with sensitives under appropriate conditions avoiding killing the mate and no cytoplasmic exchange occur two kinds of clones emerge:

1. One from original killer cell, which contains allele K (Kk) and kappa bacteria
2. Second from the original sensitive cell, which carries the allele K (Kk) and lacks kappa

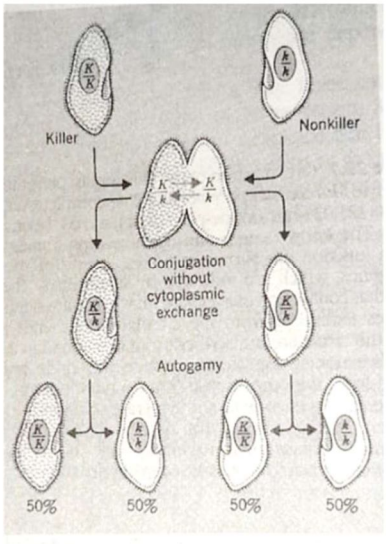
Following autogamy, half of the progeny of the killers are killers and half are sensitives. All the progeny of sensitives are sensitives. Since no cytoplasm was transferred in this process, only the cells from original killers inherit kappa bacteria. Kappa cannot reproduce in cells lacking K allele in nucleus. Under certain conditions, conjugations persist much longer; a large connection is established between conjugants, and cytoplasm as well as nuclear genes are exchanged.

Note: J. Preer and his colleagues studied kappa and named it *Caedobacter taeniospiralis.* Kappa occurs in at least two forms. The ***N* form**, the infective form that passes from one *Paramecium* to another, does not confer killer specificity on the host cell. The *N* form is

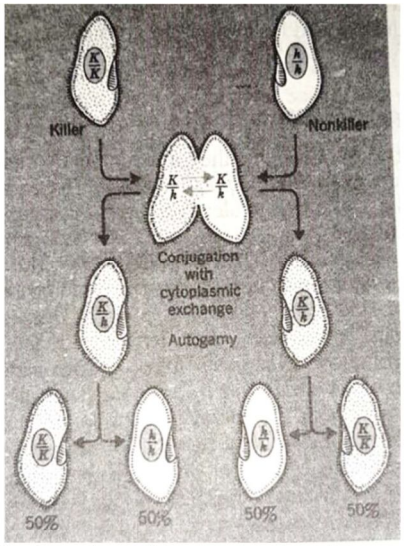
attacked by bacteriophages that induce formation of inclusions, called ***R* bodies**, inside the kappa particle and thus convert it to the ***B* form**. These *R* bodies are visible under the light microscope as refractile bodies. In the *B* form, kappa can no longer replicate; it is often lysed within the cell. It confers killer specificity on the host cell, however. The sensitives are killed by the toxin **paramecin,** which is released by the killer *Paramecium* into the environment. Precisely what steps are involved in its formation are not known, although it is plain that the virus plays an integral role. Whether the viral DNA or the kappa DNA codes the toxin is also not known at present.



Kappa particle in *P. aurelia* (a) killer (b) sensitive



Conjugation between a killer and sensitive paramecium and autogamy in homozygote



Conjugation without cytoplasmic exchange followed by autogamy