

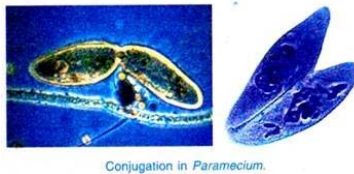
Conjugation:

Ordinarily *Paramecium caudatum* multiplies by binary fission for long periods of time, but at intervals this may be interrupted by the joining of two animals along their oral surfaces for the sexual process of conjugation.

Conjugation is defined as the temporary union of two individuals which mutually exchange micro nuclear material. It is unique type of a sexual process in which two organisms separate soon after exchange of nuclear material.

Sonneborn (1947), on the basis of mating behaviour of *Paramecium Caudatum*, has reported that each species of *Paramecium* exists in a number of varieties or syngens. Further, within each syngen there are a number of mating types usually two.

The mating types remain morphologically identical but they exhibit physiological differences. In *P. aurelia*, there are 14 syngens and 28 mating types, while in *P. caudatum*, there are 16 syngens and 32 mating types. Observations have been made that usually paramecia neither conjugate with members of their own mating type nor with the other varieties, but only with the second mating type of their own variety.



Factors Inducing Conjugation:

The factors inducing conjugation vary from species to species but some of them are given below:

1. Conjugation occurs usually under un-favourable living conditions; starvation or shortage of food and particular bacterial diet or certain chemicals are said to induce the process of conjugation in certain species of *Paramecium*.
2. Conjugation occurs after about 300 asexual generations of binary fission, or it alternates with binary fission at long intervals to rejuvenate the dying clone, i.e., it occurs in the individuals which must have passed through desirable number of asexual generations, said to be the period of immaturity, and then they become sexually mature to conjugate.
3. Conjugation occurs when there is a change in the physiological condition of paramecia, then it occurs between such individuals which are somewhat smaller in size (210 microns long) and

they are at a stage which may be regarded as a period of unhealthy old age; the paramecia of this condition will die if not allowed to conjugate.

4. Sudden darkness in light conditions and low temperatures are said to induce the process of conjugation in some species.

5. Conjugation does not take place during night or darkness; it starts in early morning and continues till afternoon.

6. A proteinaceous substance in the cilia of mating type individuals is said to induce conjugation.

Process of Conjugation:

The process of conjugation differs in different species of *Paramecium*, but the undernoted account relates to the conjugation process of *P. caudatum* (Fig. 20.21).

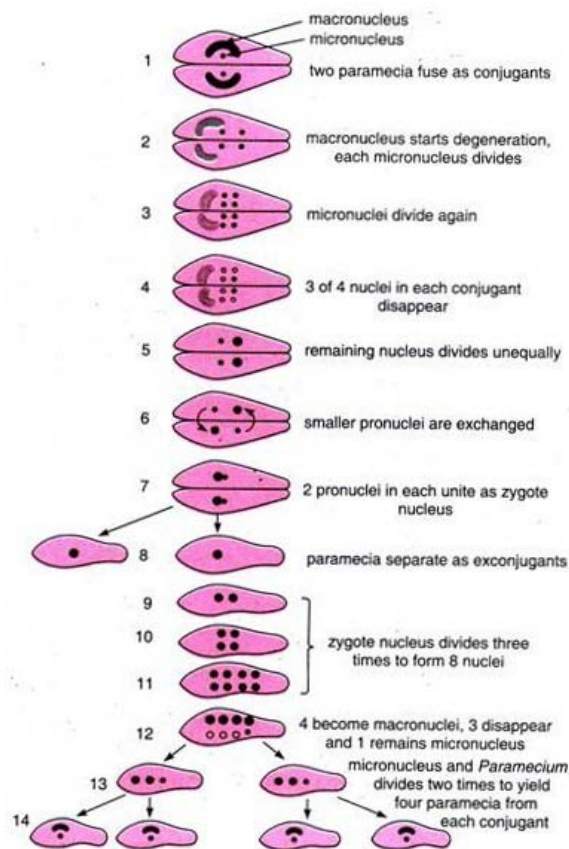


Fig. 20.21. *Paramecium caudatum*. Stages of conjugation.

In conjugation two *Paramecium caudatum* (referred to as pre-conjugants) of the opposite mating types of the same variety come together with their ventral surfaces and unite by their oral

grooves; their cilia produce a substance on the surface of the body which causes adhesion of the two conjugating paramecia.

They stop feeding and their oral groove apparatus disappears. The pellicle and ectoplasm, at the point of contact, of both break down, and a protoplasmic bridge is formed between the two animals. Now, these individuals are called conjugants.

In this condition, the conjugating pair swim actively and simultaneously a series of nuclear changes take place in each conjugant as described below:

The macronucleus begins to disintegrate, it becomes loose in texture and forms a complex twisted skein, during the latter half of the conjugation period it will finally disappear being absorbed in the cytoplasm. The micronucleus of each conjugant divides twice, one of them being a reduction division.

Thus, four haploid daughter micronuclei are produced in each conjugant. Three of these four micronuclei degenerate in each, so that only one remains.

The remaining micronucleus of each conjugant divides mitotically into two unequal pronuclei or gametic nuclei forming a larger stationary female pro-nucleus and a smaller, active migratory male pro-nucleus.

The migratory pro-nucleus of one conjugant crosses over the protoplasmic bridge and fuses with the stationary pro-nucleus of other conjugant to form a synkaryon or conjugation nucleus in which the diploid number of chromosomes is restored and there has been an exchange of hereditary material.

The process has been compared with fertilisation in higher animals, but this is not fertilisation because no gametes are involved. The conjugants now (after about 12-48 hours) separate and are called ex-conjugants. The synkaryon of each ex-conjugant divides three times to form eight micronuclei in each ex-conjugant.

Four of the eight micronuclei enlarge and become macronuclei, and three of the other four micronuclei disappear.

The remaining micronucleus divides and at the same time the ex-conjugant divides by binary fission into two cells, each having two macronuclei and one micronucleus. The cells and their

micronuclei divide a second time to form four paramecia from each ex-conjugant, so that each has one macronucleus and one micronucleus.

The new macronucleus, as also the micronucleus, have been made of new material. These new nuclei probably contain new and different potential which is reflected in the healthy individuals.

Significance of Conjugation:

A clone will die out if nuclear re-organisation does not occur, but the clone can be rejuvenated to regain its former vigour by nuclear rearrangement, this nuclear re-organisation is brought about by conjugation, thus, conjugation is essential for continued binary fission.

The significance of conjugation has been summarised below:

1. Conjugation serves as a process of rejuvenation and re-organisation by which the vitality of the race is restored. If conjugation does not occur for long periods, the paramecia weaken and die. (Woodruffs claim of keeping paramecia healthy for 22,000 generations without conjugation is disproved by Sonneborn, because he showed that all of Woodruffs paramecia belonged to the same mating type).
2. There is no distinction of sex in conjugants though only paramecia of two different mating types of the same variety will conjugate.
3. There is no distinction of sex, yet the active migratory pro-nucleus is regarded as male and the stationary pro-nucleus as the female.
4. Conjugation is only a temporary union, there is no fusion of cytoplasm and no zygote is produced, but the nucleus of each ex-conjugant contains hereditary material from two conjugating individuals.
5. Conjugation brings about replacement of the macronucleus with material from the synkaryon, this is an event of fundamental importance. In binary fission the chromosomes of the macronucleus were distributed at random to the daughter cells, continued binary fission had made the clone weak with some structural abnormalities.

Conjugation brings about the formation of the correct number of chromosomes in the macronucleus, so that the race is renewed in vigour. The role of the micronucleus is to restore a balanced chromosome and gene complex.