CONJUGATION IN PARAMECIUM

Conjugation (sexual reproduction)

- Frequently referred to as sexual reproduction.
- It is simply the temporary union of 2 individuals who mutually exchanging part of their micronuclear materials.
- It is a unique process in which 2 individuals separates soon after the exchange of their nuclear materials.
- This process in paramecium occurs frequently between binary fission and is necessary for the continued vitality of the species.

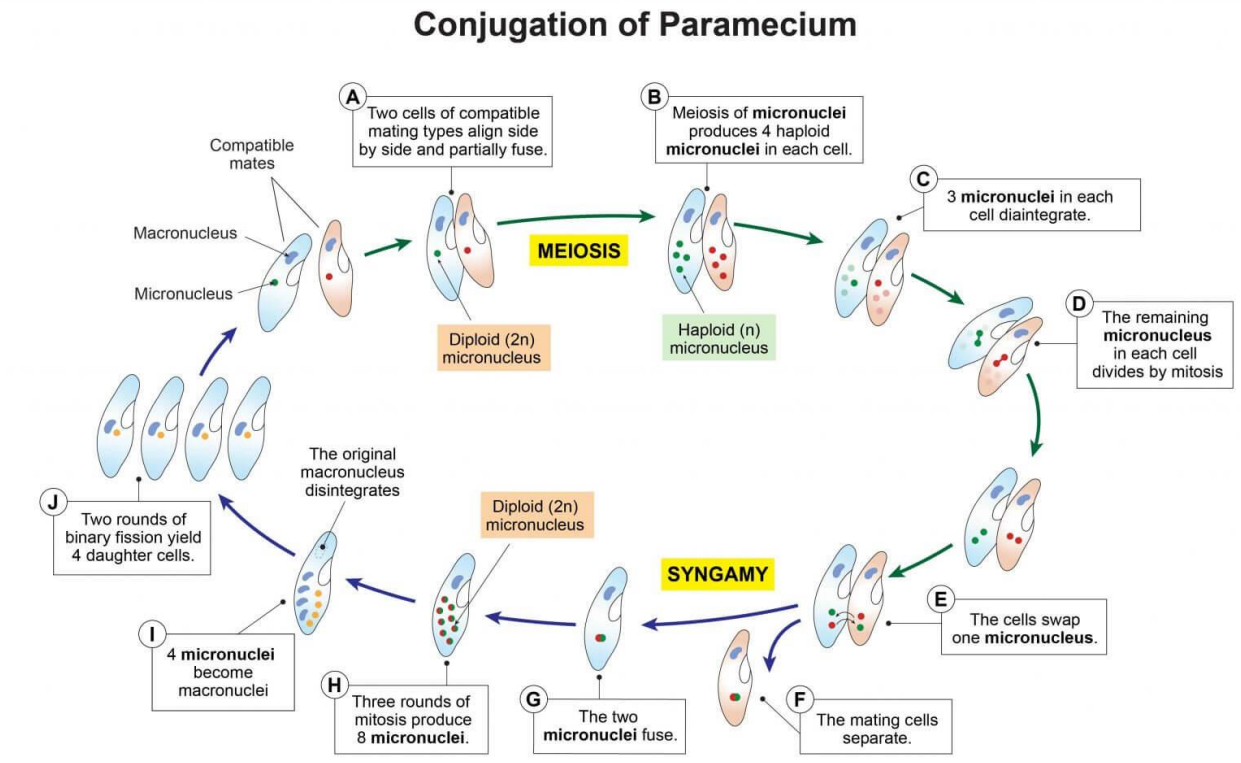

Figure: Steps of paramecium's conjugation.

Process of conjugation

- It differs slightly in different species of paramecium. The following is related to *P. caudatum*.
- In conjugation (sexual reproduction) the two paramaecia or **preconjugates** from 2 different mating types of the same variety come in contact ventrally and unite through the edges of their oral groove.
- Their cilia produce a substance on the surface of the body which causes the adhesion of 2 conjugating paramecia.
- They then stop feeding and their buccal structure disappears.
- The pellicle and ectoplasm, all along with the union of two forms, are disintegrated and a **protoplasmic bridge** is formed between 2 individuals.
- Now, at this stage, they are called gametocytes or conjugant.
- The conjugating pair continues to swim actively, and a series of nuclear changes take place in each conjugant.
- The macronucleus simply breaks up into fragments, which are later absorbed by the cytoplasm.
- And diploid micronucleus of each conjugant first grows in size and divides by meiosis.
- And forms 4 haploid daughter micronuclei.
- Out of these four micronuclei, three daughter micronuclei disintegrate or become pyknotic and disappear in each conjugant, while the remaining one divides into two unequal daughter **pronuclei** or **gamete nuclei**.
- Of these, the smaller one is the active **male migratory pro-nucleus**, whereas the larger one is the **stationary female pro-nucleus.**
- The migratory male pro-nucleus of each conjugant moves through the protoplasmic bridge into the other conjugant and ultimately fuses with stationary female pro-nucleus forming a **zygote nucleus** or **synkaryon** in which the diploid number of chromosomes is restored and there has been exchanged of hereditary material.
- The nucleus of the zygote is diploid and is called **amphinucleu**s and this type of mixing of two nuclei from different individuals is called amphimixis.
- The 2pairing paramecia, after a union of 12 to 48 hrs. separate and now called **exconjugants**.

- In each exconjugants, the zygote nucleus divides by mitosis 3 times in rapid succession producing 8 micronuclei, of which 4 enlarge to become **macronuclei** and 4 to become
- 3 micronuclei disintegrate and disappear.
- while remaining micronucleus divides with binary fission of exconjugants.
- Now, from each conjugant 2 daughters, paramecia are obtained, each containing 2 macronuclei and 1 micronucleus.
- The micronucleus again divides with the division of each daughter paramecium, forming 2 individuals each containing one macronucleus and one micronucleus.
- At the end conjugation, 4 daughter individuals are produced from each conjugant.

Factor and condition of conjugation

Conjugation is very complex physiologically. The factor inducing conjugation varies from species to species. some of them are:

- Occurs under an unfavorable condition like starvation or shortage of food and particular bacterial diet or certain chemicals.
- Sudden darkness in light conditions and low temperature differing with species is said to essential for conjugation.
- Occurs when there is a change in the physiological condition of paramecia, it occurs between such individuals which are smaller in size (210 µm long) than the normal individuals (300-350 µm long).
- Conjugation occurs after about 300 asexual generations of binary fission, or it alternates with binary fission at long intervals to rejuvenate the dying clone.
- Conjugation usually starts early morning and continued till afternoon. It does not take place during the night or darkness.
- The pairing conjugants are **isogamous** and there is no morphological sexual dimorphism into male and female conjugants.
- Conjugation occurs only between individuals belonging to different mating types. It never takes place among the members of a ‘pure line’, that is among the descendants of a single individual.
- A proteinaceous substance in the cilia of mating-type individuals is said to induce conjugation.

Significance of conjugation

A clone will die out if nuclear reorganization does not occur, but the clone can be rejuvenated to regain its former vigor by nuclear arrangement, this is brought about by conjugation. Thus, conjugation is essential for continued binary fission. The significance of conjugation is described below:

- If binary fission continues repeatedly for a longer period of time, *Paramecium* loses its vigor and physiologically depressed, reduces in size, ceases to multiply, degenerates in the organization, and eventually die. So, to avoid this senile decay of race, conjugation serves as a process of **rejuvenation** or **reorganization** by which the vitality of race is restored. However, **Woodruff** and **Jennings** do not support the view that conjugation helps in rejuvenescence. Woodruff claim of keeping paramecium healthy for 22,000 generations without conjugation.
- There is no distinction of sex in conjugation though only paramecia of different mating types of the same variety will conjugate.
- There is no distinction of sex, yet the active migratory pronucleus is regarded as male and the stationary pronucleus are regarded as female.
- Conjugation ensures the **inherited variation.** It brings about the blending of 2 lines of ancestry just as bisexual reproduction does but in asexual reproduction, the hereditary material of the parent passes unchanged on to the progeny. So, all *paramecium* has the same inheritance.
- Conjugation brings about the **replacement of the macronucleus** with material from the zygote nucleus, this is an event of fundamental importance.
- Conjugation brings about the **formation of the correct number of chromosome** in the macronucleus, so the race is renewed in vigor and vitality to accelerate the metabolic activities but in binary fission chromosome of the macronucleus were distributed at random to the daughter cell, continued binary fission had made the clone weak with some structural abnormalities.