Reproduction in Paramecium

B.Sc. Part-I, Paper-I

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Introduction

Paramecium can reproduce either asexually or sexually, depending on their environmental conditions. Asexual reproduction takes place when ample nutrients are available, while sexual reproduction takes place under conditions of starvation. In addition, paramecia can also undergo several kind of nuclear reorganization and self fertilization.

Different mode of reproduction in Paramecium are as follows:-

- Binary fission
- Conjugation
- Autogamy
- Cytogamy
- Endomixis

Binary fission

Paramecium reproduces asexually by transverse binary fission, in which the micronucleus passes through characteristic stages of mitosis, whereas the macronucleus simply divides by amitosis.

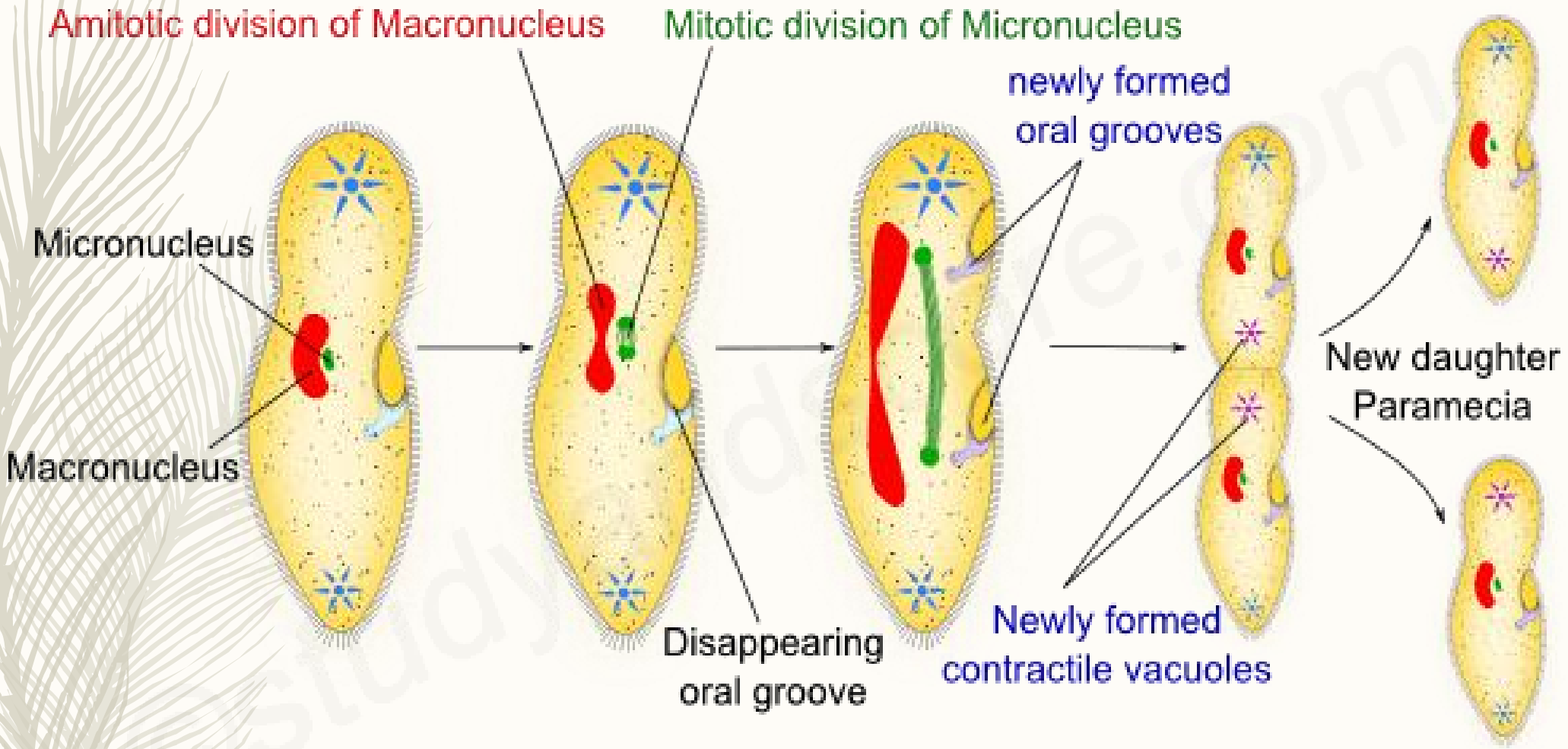
The mature cell divides into two cells and each grows rapidly and develops into a new organism. Under favourable conditions, Paramecium multiplies rapidly up to three times a day.

Binary fission divides a cell transversely and followed by mitotic division in the micronucleus.

Macronucleus divides amitotically.

The gullet also divides into two halves.

Although the favoured mode of reproduction in Paramecium is mostly asexual, they reproduce sexually too, when there is a scarcity of food.



STEPS IN TRANSVERSE BINARY FISSION IN PARAMECIUM

Conjugation

It is a kind of sexual reproduction unique to ciliates, in which a temporary union of two individuals of the same species takes place for exchanging their genetic material.

The process takes place as follows:

Two individuals or preconjugants, lose their oral groove and cilia and come in contact and firmly unite together.

Macronucleus disintegrates into the cytoplasm.

The micronucleus divides by meiotic division and then mitotic division to produce four haploid daughter micronuclei.

Three daughter micronuclei degenerate and one survives, which then divides by mitosis forming two unequal gametic nuclei – one the smaller migratory gametic nucleus and the larger stationary gametic nucleus.

Migratory nucleus of one individual migrates through cytoplasmic bridges to the other individual's cytoplasm and fuses with the stationary nucleus forming a zygotic nucleus or synkaryon. The two paramecia now termed exconjugants.

Conjugation

The exconjugants separate and the conjugation is over.

In each exconjugant zygote, nucleus divides mitotically three times producing 8 daughter nuclei.

Four daughter nuclei in each exconjugant enlarge to become macronuclei and other 4 become micronuclei.

Three micronuclei disintegrate and disappear.

Remaining one micronucleus divides by binary fission, which produces 2 daughter *Paramecia*, each containing 2 macronuclei and 1 micronucleus.

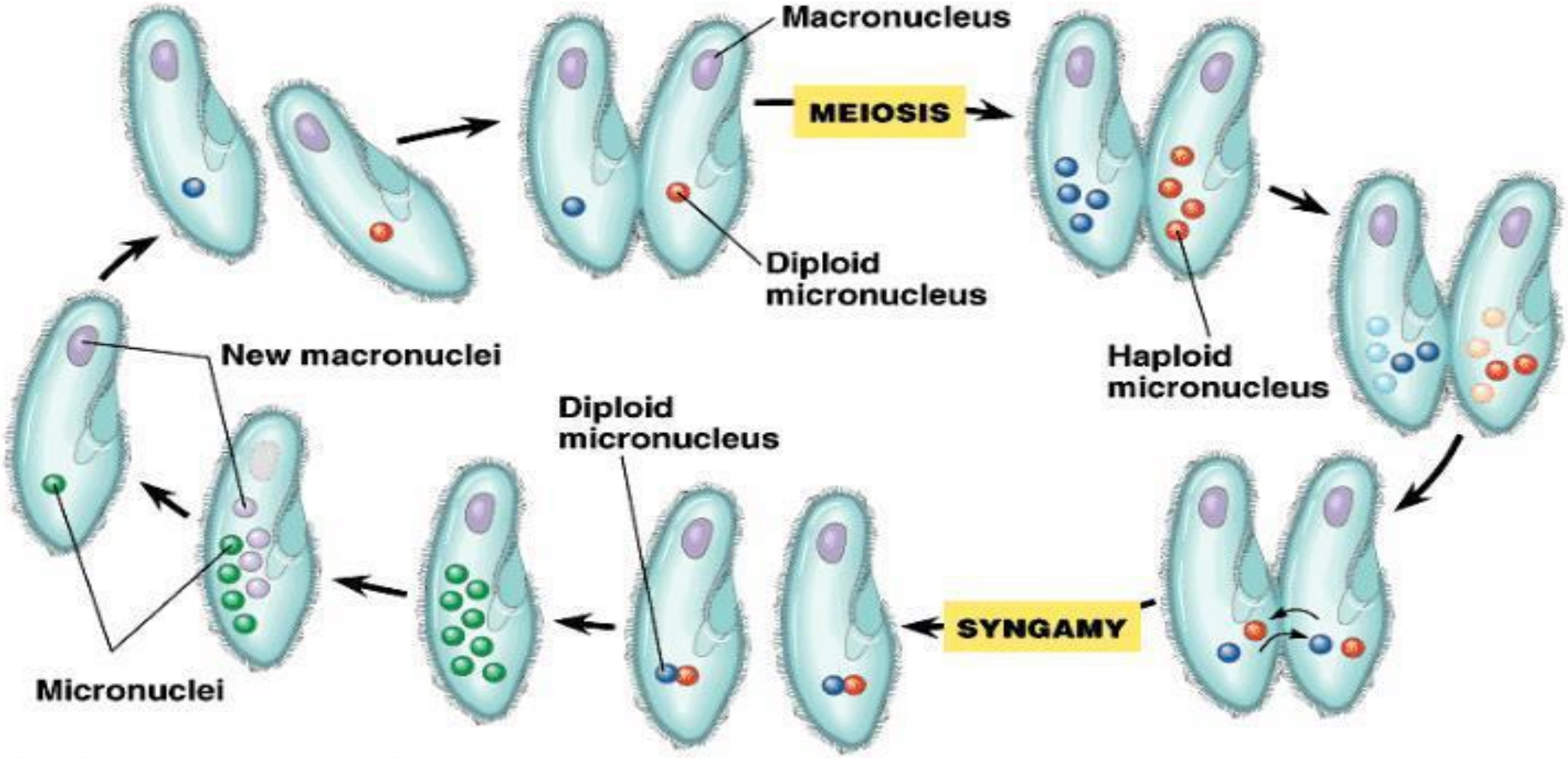
Further division of each daughter cell forms 2 individuals, each containing one macronucleus and one micronucleus.

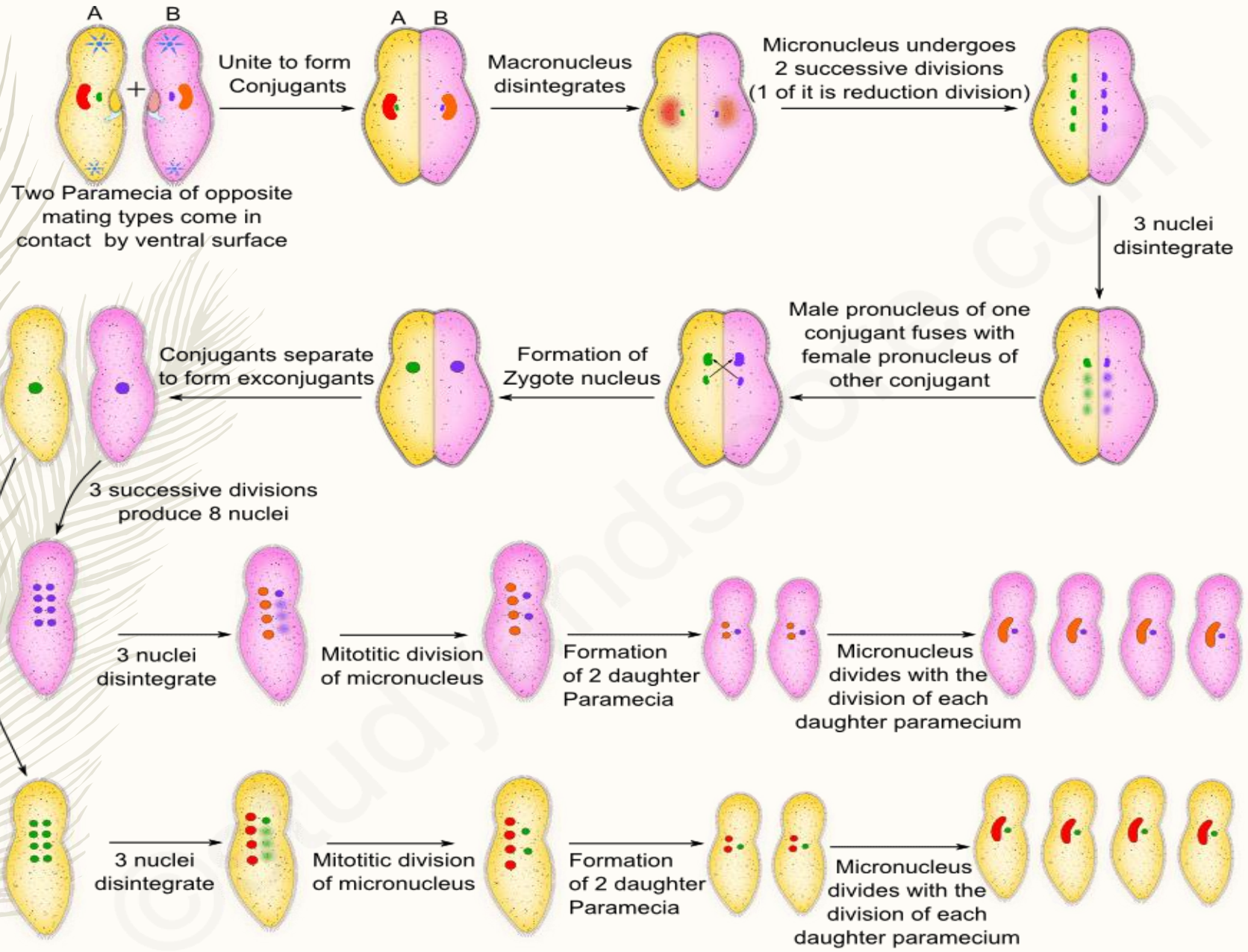
Thus, each conjugant produces four daughter individuals at the end of conjugation.

Significance of conjugation

Conjugation rejuvenates individuals. If binary fission continues repeatedly for several generations, *Paramecium* loses its vigour. To regain vitality conjugation is resorted to and the process seems to rejuvenate and revive the lost vigour of asexual reproduction. During conjugation the nuclear apparatus is reorganized. The periodic occurrence of conjugation ensures heritable variations in the species.

Paramecium- Conjugation





STEP WISE REPRESENTATION OF CONJUGATION PROCESS IN PARAMECIUM

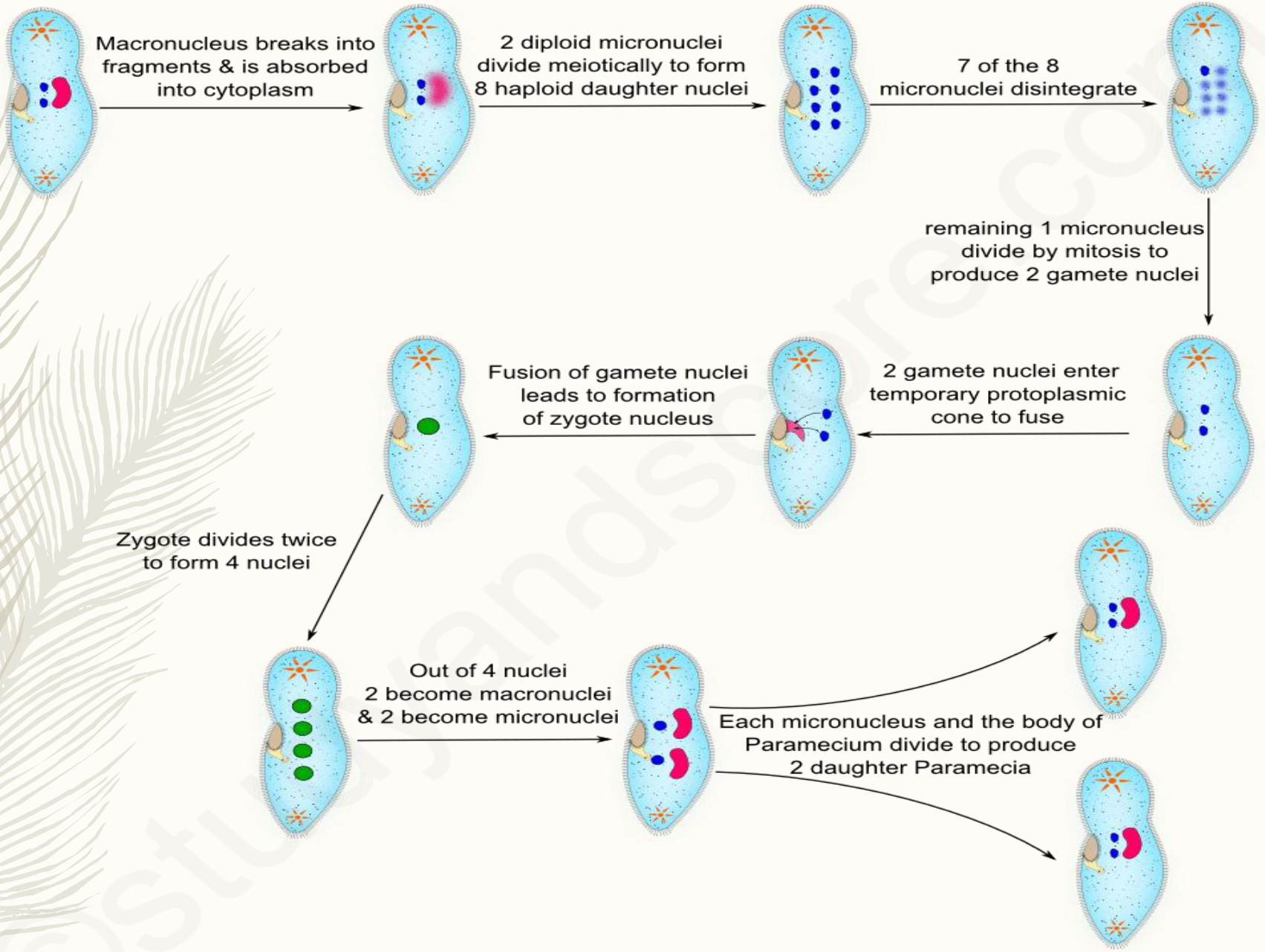
Autogamy

"Autogamy is essentially the same thing as conjugation, but it is only happening with a single cell, "During this process, the micronucleus replicates multiple times. One of these new micronuclei undergo rearrangement of their genetic content.

During autogamy in P. aurelia, the two micronuclei divide twice (once meiotically) to form eight micronuclei, six of which degenerate. Meanwhile the macronucleus grows in and breaks into pieces later to be absorbed in the cytoplasm. Two of the eight micronuclei, as pronuclei, enter a protoplasmic cone bulging near the cell mouth.

The two pronuclei fuse to form synkaryon. The synkaryon divides twice to form four micronuclei. Two micronuclei become macronuclei. The Paramecium and its micronuclei divide to form two daughter individuals, each with one macronucleus and two micronuclei. This process is completed in about two days.

Autogamy brings about rejuvenation of the race.



STEP WISE REPRESENTATION OF AUTOGAMY IN PARAMECIUM AURELIA

Paramoecium aurelia has 1 macronucleus & 2 micronuclei

Cytogamy

R.Wichterman (1940) reported in *P. caudatum* a sexual process without nuclear exchange and termed it cytogamy.

There is no nuclear exchange between the two individuals because of the absence of cytoplasmic cross bridges.

Two haploid gametic nuclei in each individual fuse in self fertilization to produce a diploid zygote.

Cytogamy differs from autogamy in that there are two animals in contact with each other, but it resembles autogamy and conjugation in the fusion of two pronuclei.

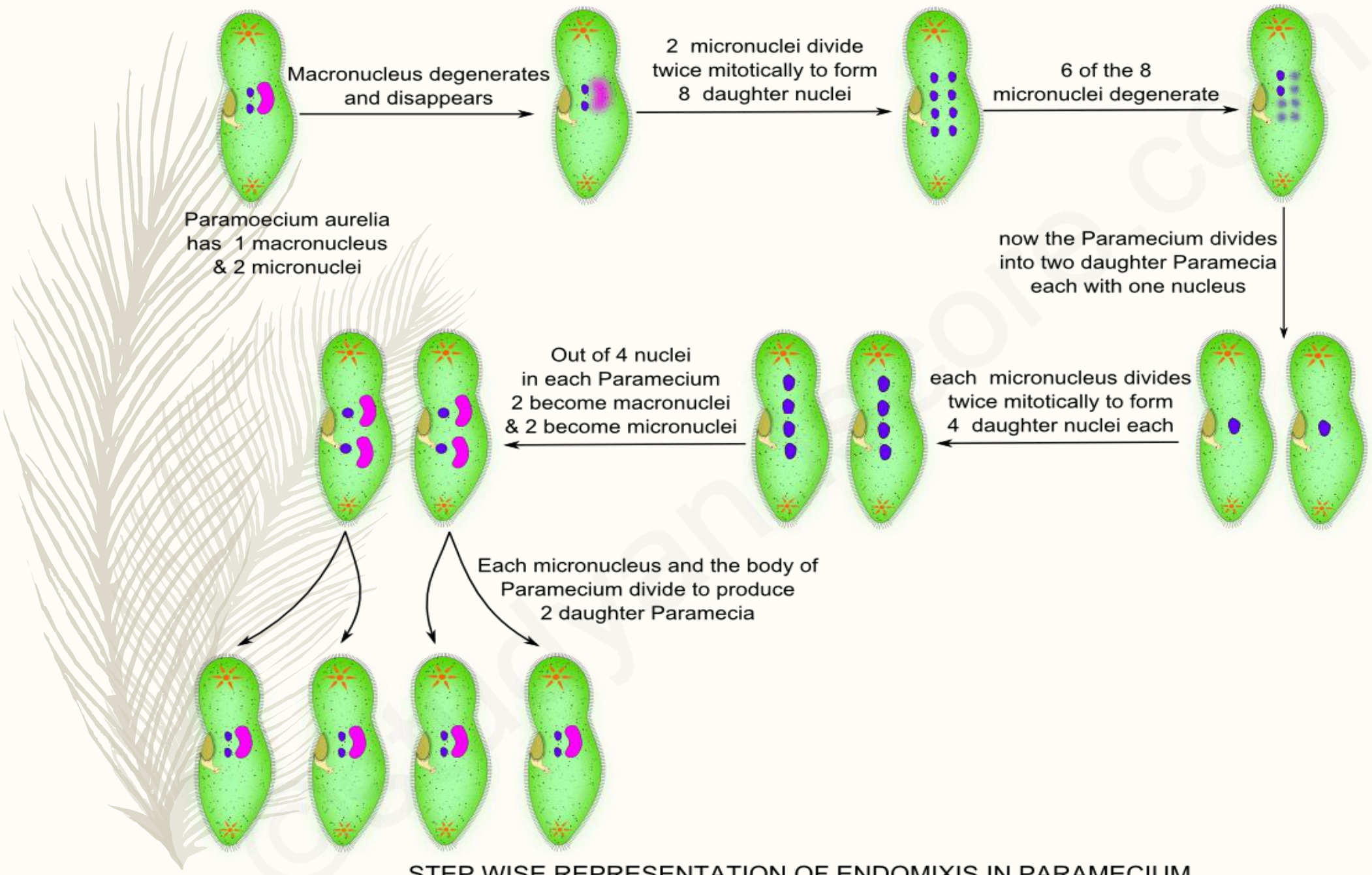
Cytogamy differs from conjugation in that there is no nuclear exchange between the two animals which come together.

Endomixis

It involves a total internal nuclear reorganization within an individual.
In *Paramecium aurelia* and takes place in a single individual without any reduction division.

Endomixis occurs in that variety of P. aurelia which does not conjugate, hence, the effect of endomixis may be the same as that of the conjugation since both processes bring about replacement of the macronucleus with material from the micronucleus, and both processes rejuvenate the vitality of the race.

But the two processes differ because there is no fusion of pronuclei in endomixis.



STEP WISE REPRESENTATION OF ENDOMIXIS IN PARAMECIUM