

Ascomycotina: *Saccharomyces*

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Cell Structure of Saccharomyces

- The genus *Saccharomyces* (Gr. *Saccharon*, sugar; *mykes*, fungus), commonly known as Brewer yeast or Backer's yeast is used widely in wine and baking industry.
- The thalloid plant body is unicellular, but during rapid multiplication by budding the cells may remain attached in chain forming pseudo- mycelium (Fig. 4.38).
- The cells may be globose, elliptical, oval to even rectangular in shape and measure about 5-6 x 6-8 μm .
- Electron microscopic studies and chemical analysis of *Saccharomyces cerevisiae* show that the cells are surrounded by a distinct cell wall with three layers.
- The outermost layer mainly consists of protein-mannan and some chitin; the middle layer mainly of glucan and the innermost layer consists of proteinglucan.

Kingdom – Mycota

Division – Eumycota

Sub- division – Ascomycotina

Class – Hemiascomycetes

Order – Endomycetales

Family – Saccharomycetaceae

Genus – *Saccharomyces*

Species – *cerevisiae*

Cell structure

- Inner to the cell wall is the cell membrane (plasmalemma), i.e., an usual unit membrane having series of shallow, elongated pits or invaginations.
- In the centre, the cell having a large central vacuole, limited by a single membrane, the tonoplast, which contains a watery substance, granules of polymetaphosphate and lipid.
- The cytoplasm is granular and contains organelles like nucleus, mitochondria, golgi apparatus, endoplasmic reticulum, ribosome and other substances like glycogen bodies, volutin granules, oil globules etc.
- The nucleus having outer perforated double unit membrane remains by the side of the vacuole.
- The nucleus is bipartite in nature having major Feulgen positive and a smaller Feulgen negative regions

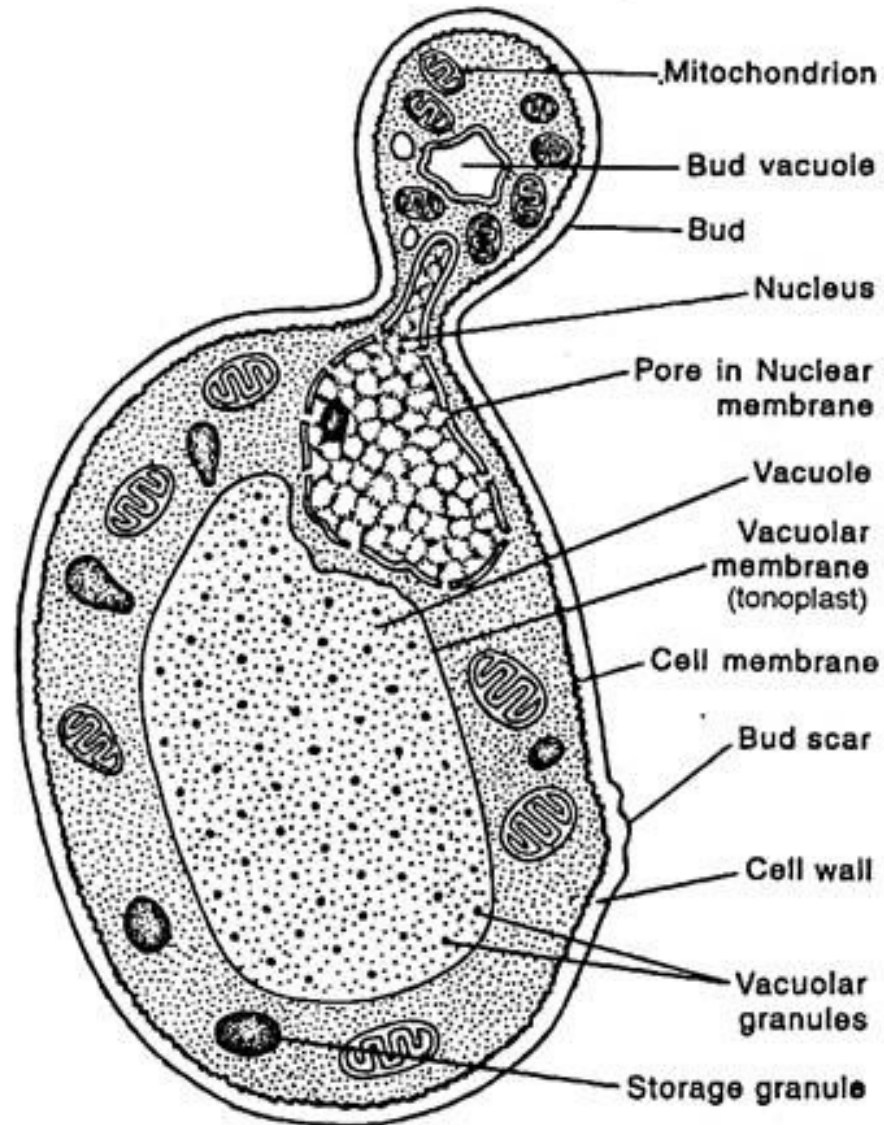


Fig. 4.35 : Structure of a budding cell of *Saccharomyces cerevisiae* under Electron microscope

Reproduction in Saccharomyces

- **A. Vegetative Reproduction:**
- Vegetative reproduction takes place by fission and budding.
- **(a) Fission:**
- It takes place during favourable conditions. In this process, a single vegetative cell forms two daughter cells of equal size. During fission, a constriction appears in the middle of the cell and simultaneously the nucleus undergoes mitotic division.
- Both the steps progress simultaneously. After nuclear migration, one at each side, a partition wall forms almost halfway of the mother cell and, as such, two daughter cells are formed.

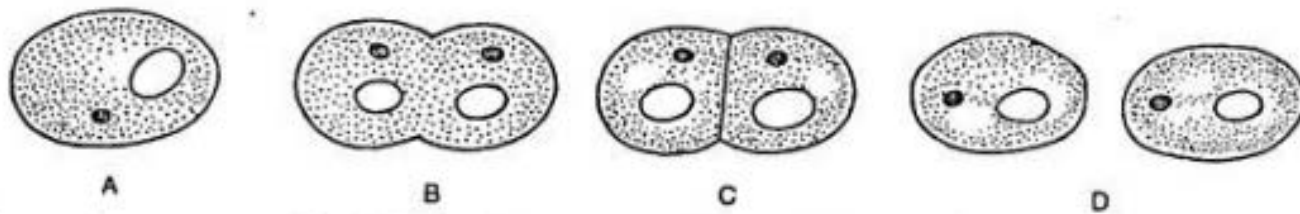


Fig. 4.36 : *Saccharomyces cerevisiae* : A-D. Stages of fission

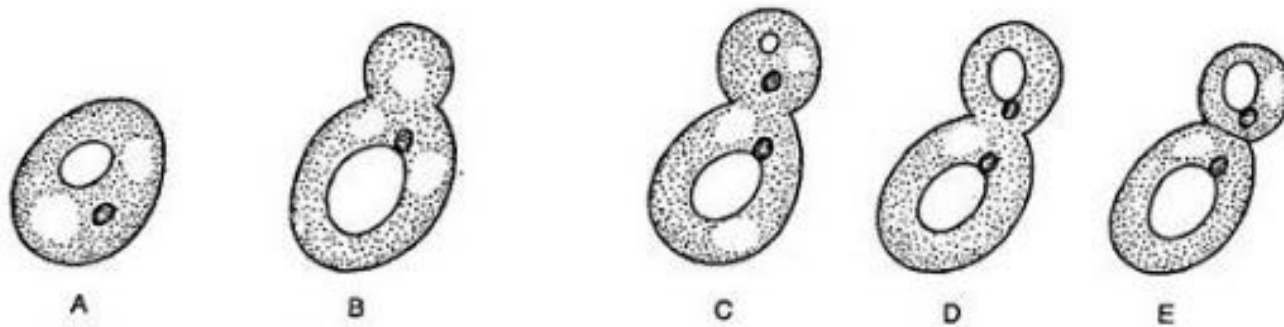


Fig. 4.37 : *Saccharomyces cerevisiae* : A-D. Stages of budding

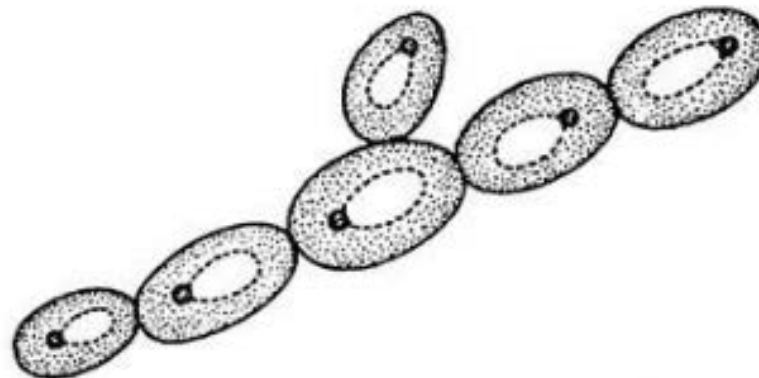


Fig. 4.38 : Pseudomycelium of *S. cerevisiae*

Budding

- Budding also takes place during favourable condition. The protoplasm of vegetative cell swells up at one side in the form of a bud. The nucleus undergoes mitotic division. Out of two nuclei formed by mitosis, one goes to the bud and other one remains in the mother. Bud enlarges and eventually cuts off from the mother by partition wall.
- The size of the bud is always smaller than the mother cell. After maturation, these bud separate from the mother and leave a convex scar on the surface, called bud scar. Similar scar with concave surface remains on the wall of the bud, called birth scar.
- Sometimes due to rapid division, large number of buds develop without being detached from one another and persist in the form of branched or unbranched chain, called pseudo-mycelium (Fig. 4.38). Finally the cells get detached and grow individually.

Asexual Reproduction

- It takes place during unfavourable condition by the formation of thick walled spore, called endospore (Fig. 4.39).
- During this process nucleus divides mitotically and forms four nuclei.
- The protoplast divides into four units, each with one nucleus and forms four endospores.
- During favourable condition, endospore germinates by budding and buds grow individually.

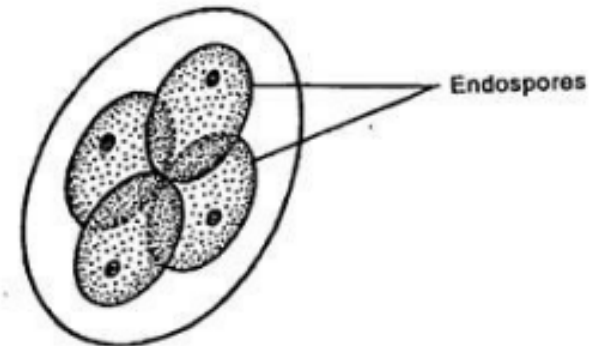


Fig. 4.39 : *Schizosaccharomyces pombe* : Endospores (four) in a cell

Sexual Reproduction

- Sexual reproduction takes place during unfavourable condition.
- In this process, two vegetative cells or ascospores behave as gametangia.
- Two such cells come very close and develop beak-like outgrowth towards each other.
- Both the outgrowths come in contact and the intervening walls between them dissolve.
- The nuclei of both the gametangia come to the fused outgrowth (conjugation tube) and they fuse therein to form a diploid zygote.
- The zygote behaves as an ascus.
- The diploid nucleus of zygote undergoes meiotic division forming 4 or 8 (with additional mitosis) ascospores.
- The ascospores are liberated by breaking the ascus wall and behave as somatic cell.

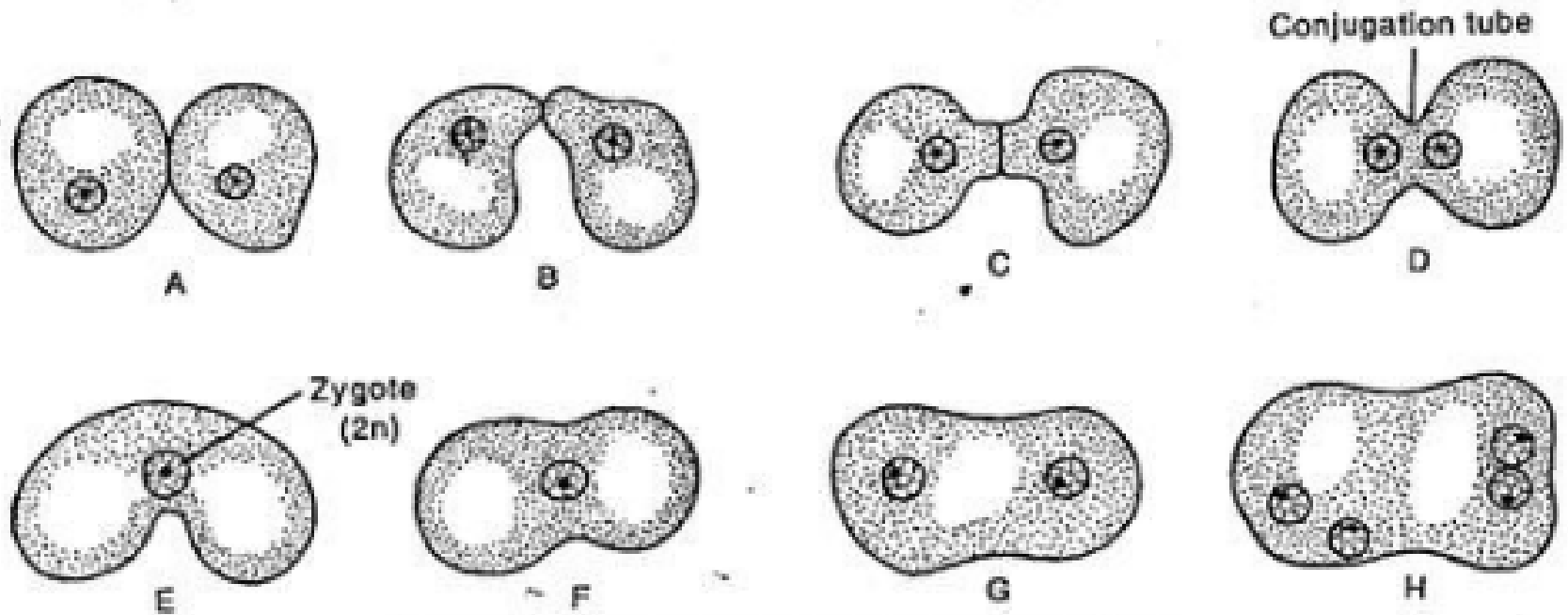


Fig. 4.40 : Different stages (A-H) of sexual reproduction

Life Cycle Patterns of Saccharomyces

- **Three patterns of life cycle are found in yeast:**
 - **Haplobiontic,**
 - **Diplobiontic**
 - **Haplodiplobiontic**

Haplobiontic Type

- This type of life cycle is characterised by more elaborate haploid phase than the diploid phase, found in *Schizosaccharomyces octosporus* (Fig. 4.41 A).
- The diploid phase is restricted only in the zygote. The vegetative cells are haploid and behave as gametangia.
- Two such gametangia fuse together and form a diploid cell.
- The diploid cell behaves as an ascus whose nucleus divides first meiotically, then mitotically; results in the formation of eight ascospores.
- After maturation, the ascospores liberate by bursting the ascus wall.
- The ascospores then behave as vegetative cell and continue multiplication through budding.

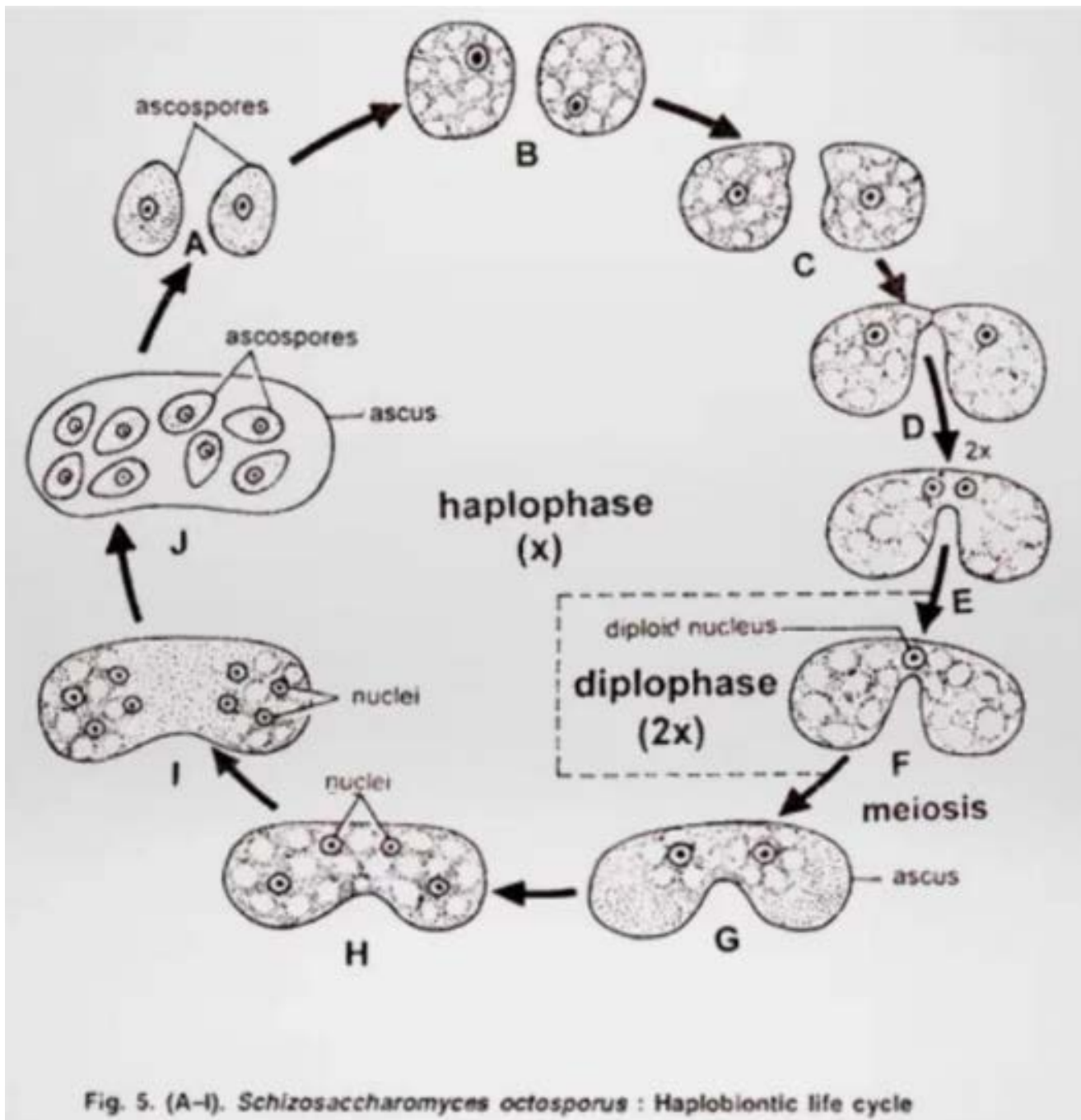


Fig. 5. (A-I). *Schizosaccharomyces octosporus* : Haplobiontic life cycle

Diplobiontic Type

- *Saccharomyces ludwigii* cells are diploid (2x), and haploid (x) phase is represented only by the ascospores ultimately expands to act as an ascus.
- During the process of sexual reproduction, the diploid nucleus splits meiotically to form 4 haploid ascospores.
- The 2 nearby ascospores of different mating type ('+' and '-') fuse (plasmogamy and karyogamy) inside the ascus and develop a diploid cell.
- Therefore, the ascospores undeviatingly act as gametangia and two diploid cells are generated inside the ascus.
- The zygote germinates in situ forming tubular outgrowth or germ tube. It penetrates its way within the ascus wall and acts as sprout mycelium and creates diploid yeast cells by budding.
- These buds are departed from the parent cells and repeat the process.

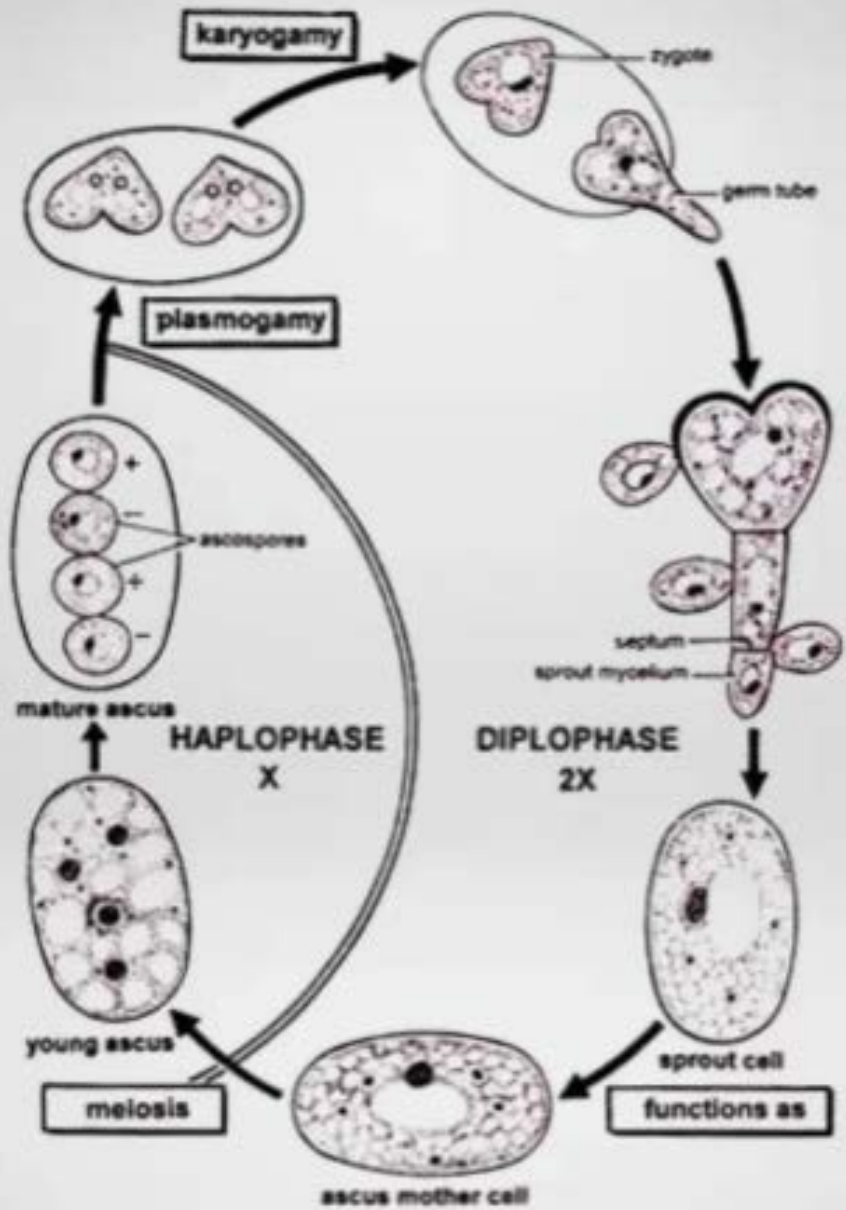
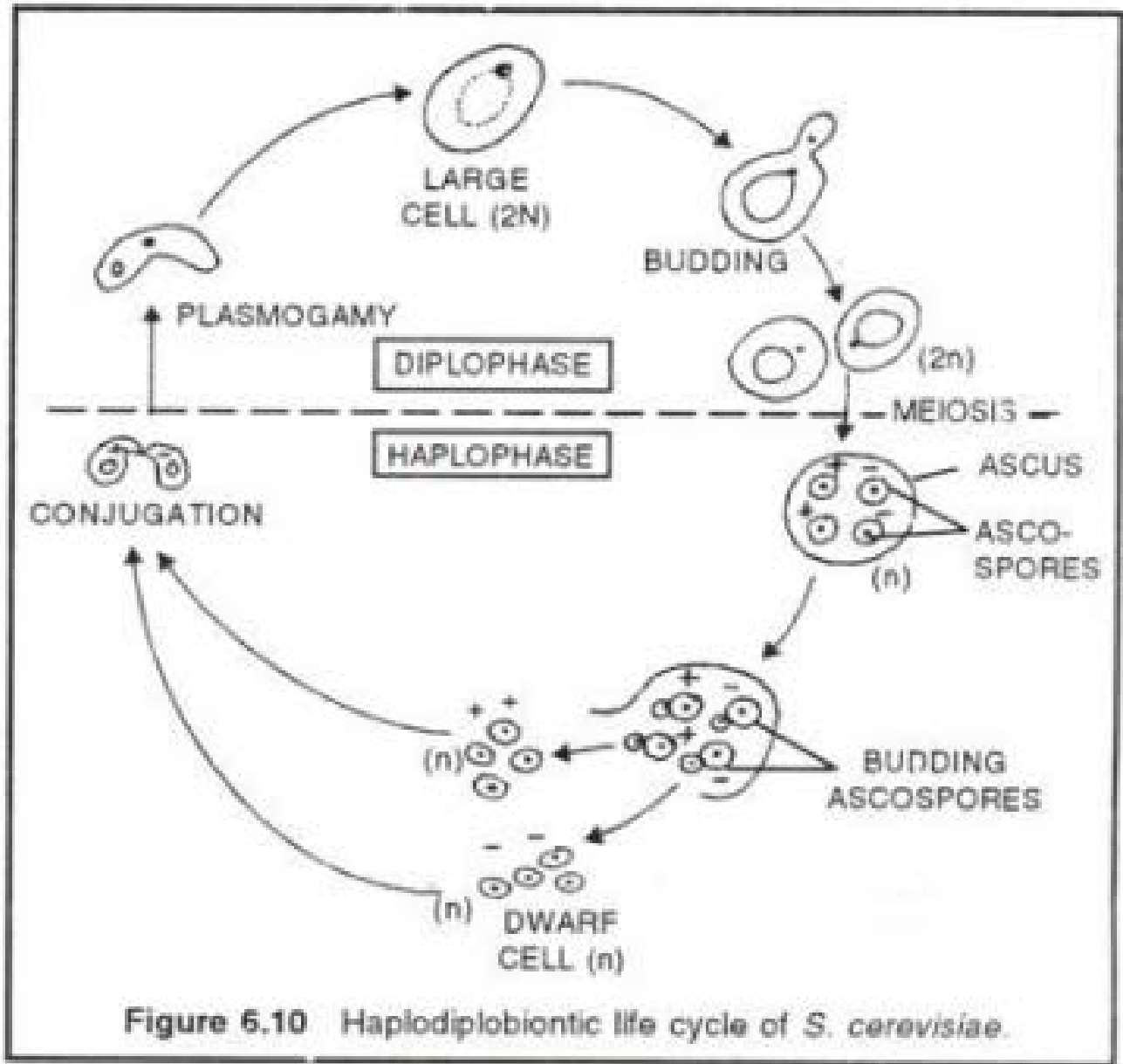


Fig. 6. *Saccharomyces ludwigii*. Diplobiontic life cycle

Haplo-Diplobiontic Type

- This type of life cycle is represented by haploid (dwarf cells) and diploid (large cell) phases, of more or less equal duration, found in *Saccharomyces cerevisiae* (Fig. 4.41 C).
- The haploid cells of opposite mating type normally multiply by budding.
- Two such cells of opposite mating behave as gametangia and undergo fusion.
- The fused gametangia develop a diploid zygote.
- The diploid zygote like the haploid cells under-goes budding and forms many diploid cells.
- With the scarcity of food, the diploid cell behaves as an ascus and by reduction division it forms four haploid ascospores.
- After liberating from the mother wall, the ascospores undergo budding and form many haploid somatic cells.



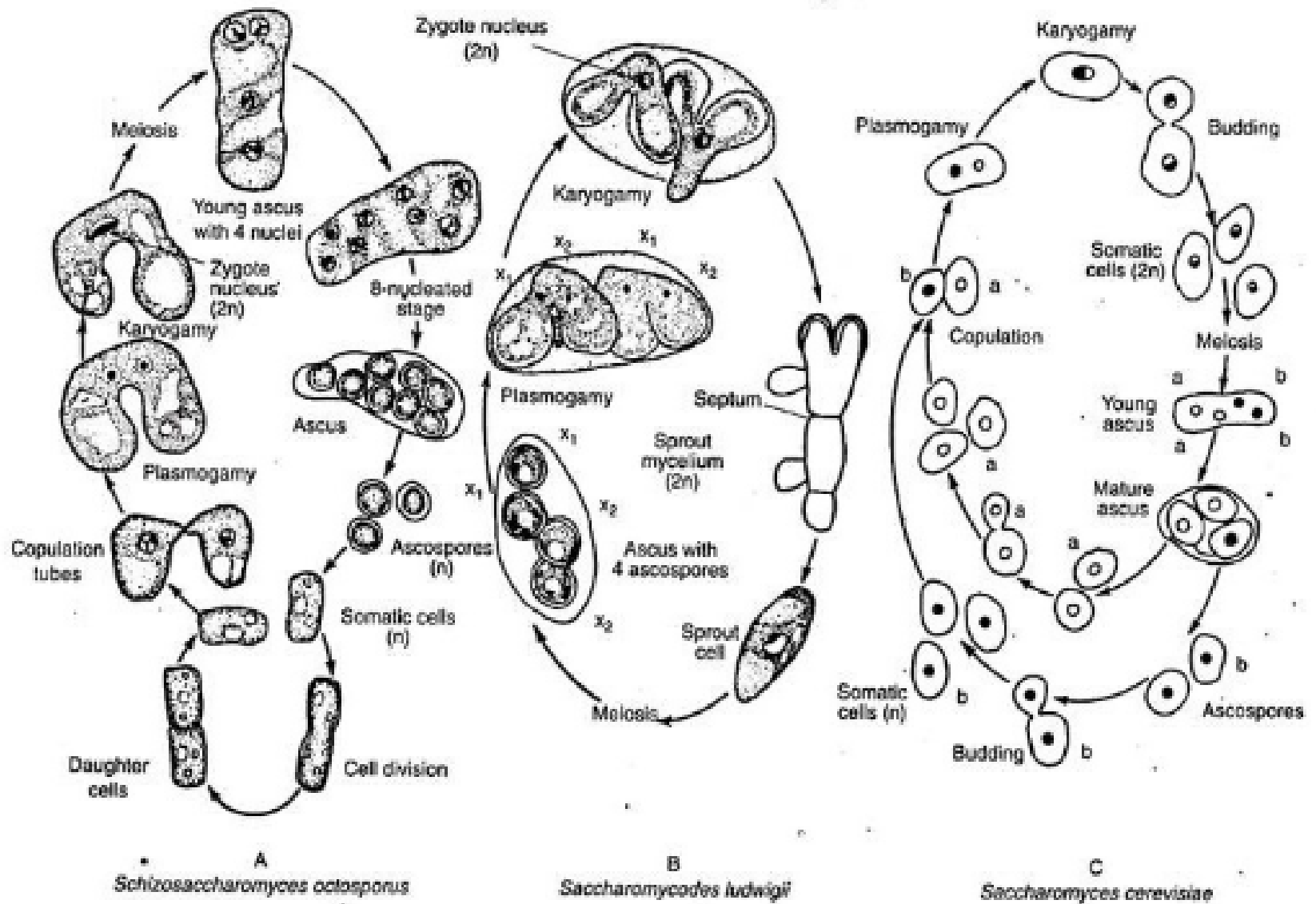


Fig. 4.41: Life cycles of three types of yeasts : A. Haplobiontic (*Schizosaccharomyces octosporus*), B. Diplobiontic (*Saccharomyces ludwigii*), C. Haplo-diplobiontic (*Saccharomyces cerevisiae*).