

ASCOMYCOTINA

SAC FUNGI

Division

Eumycota (Filamentous true fungi)

Subdivision

Mastogomycotina

Zygomycotina

Ascomycotina

Basidiomycotina

Deuteromycotina

Subdivision: Ascomycotina

(Sac fungi)

- **Sexual ascospores develop inside sac**

Classes –

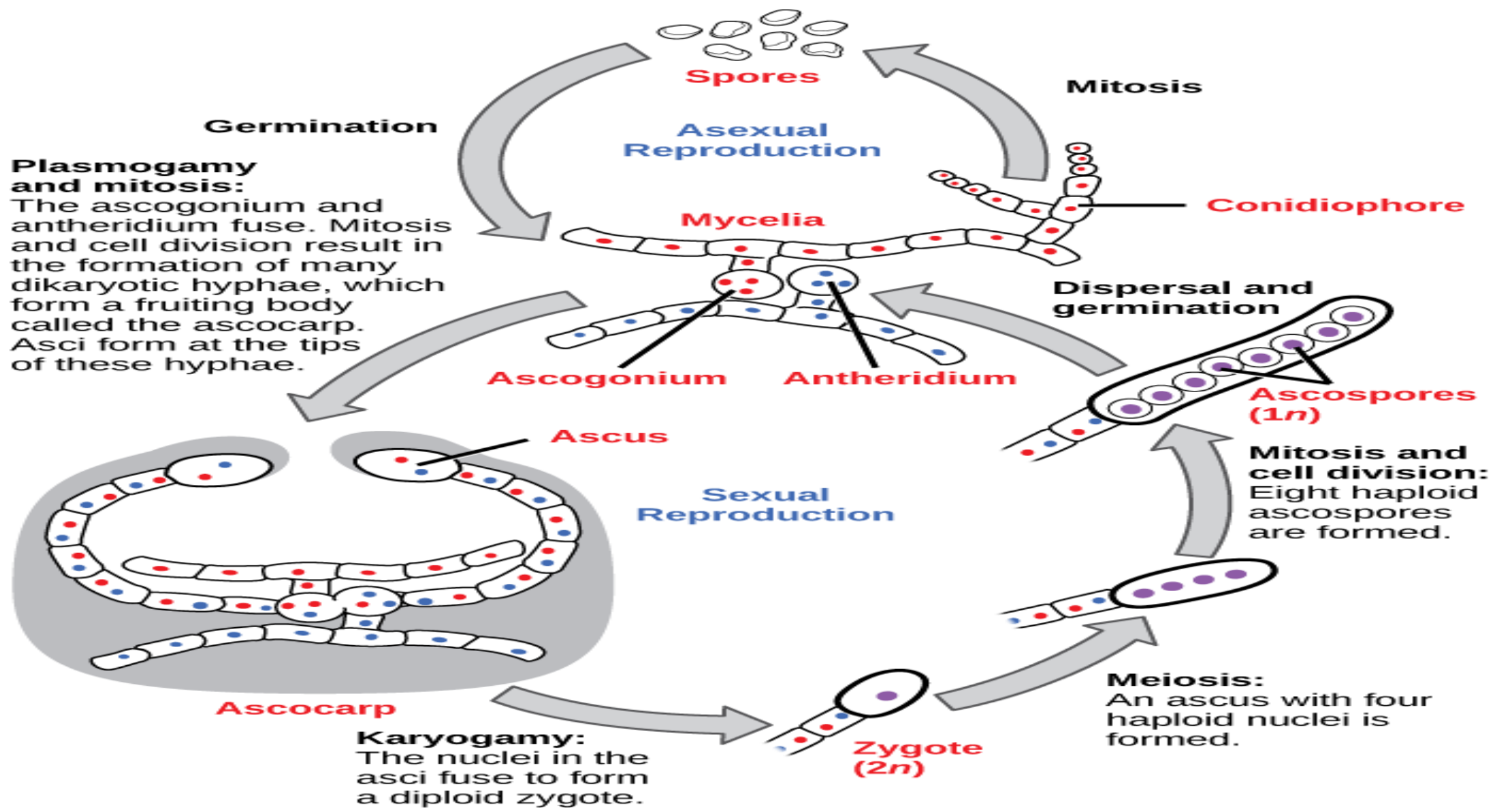
- 1. Hemiascomycetes**
- 2. Plectomycetes**
- 3. Pyrenomycetes**
- 4. Discomycetes**
- 5. Laboulbeniomyces**
- 6. Loculoascomycetes**

Sac Fungi

- Cell wall made up of chitin
- Regular septate mycelium with simple pores
- Absence of motile gametes
- Asexual conidia formation of typical structures
- Presence of dikaryophase in life cycle
- Fungi in the Hemiascomycetes have little or no mycelia and the asci are not produced in a spore-bearing structure or fruiting body

- **Asexual reproduction occurs by breaking off (fragmentation) of mycelium, by splitting of one cell into two cells (fission), by budding of cells, and by formation of conidia.**
- **Sexually produce usually 4 or 8 ascospores within a sac sporangium called an ascus**
- **Yeasts have evolved and found in sugary substances such as flower nectar and on the surface of fruits, in soil, in animal wastes, in milk, and in other substances.**
- **They have the ability to ferment carbohydrates, producing alcohol and carbon dioxide, as in wine and beer making**
- **The leaf curl disease-causing fungi are classified with the yeasts, as both may form buds on the ascospores**

Ascomycete Life Cycle



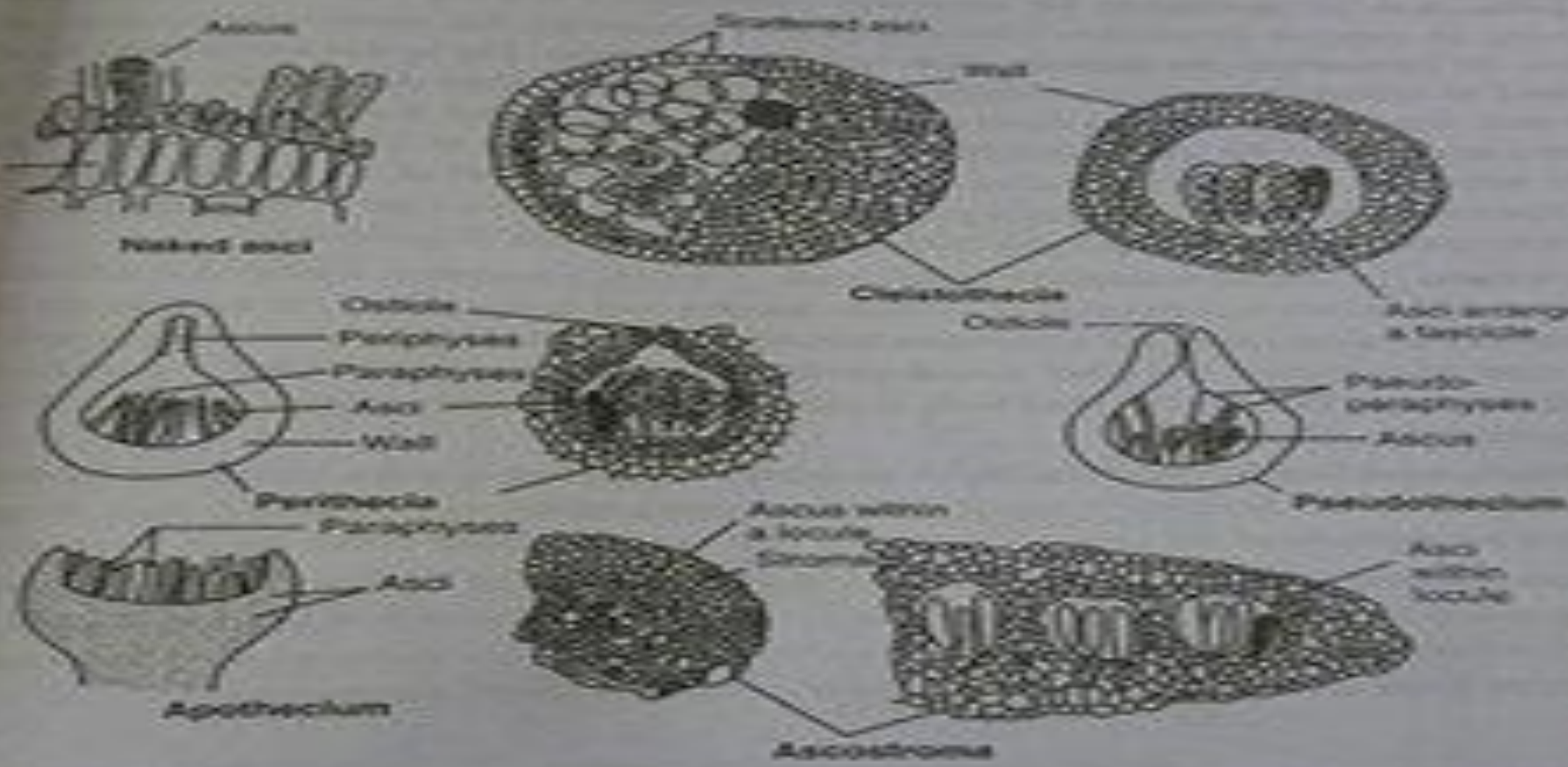


Fig. 6.3. Types of fruit bodies (ascocarps, ascomata).

1. Class – Hemiascomycetes

- **Thallus single cell**
- **Asexual reproduction by budding**
- **Asci arising naked, no ascocarp produced**
- **Industrially important**
- **Some plant pathogenic**

Examples

Saccharomyces cerevisiae (Yeast)

- Yeasts are microscopic, unicellular organisms
- Asexual reproduction occurs by cell division and budding
- Sexual reproduction, while rare, is by fusion of two cells to form an ascus with 4 ascospores (Gametangial copulation or hologamy)

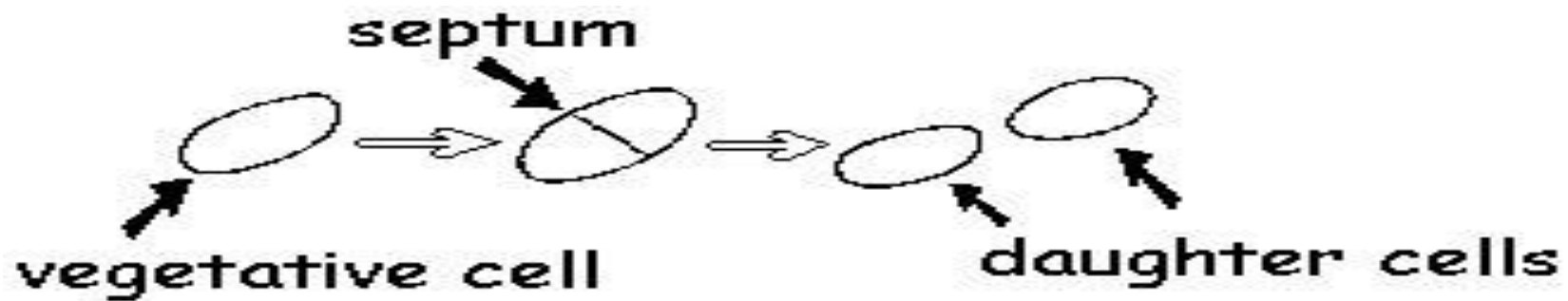
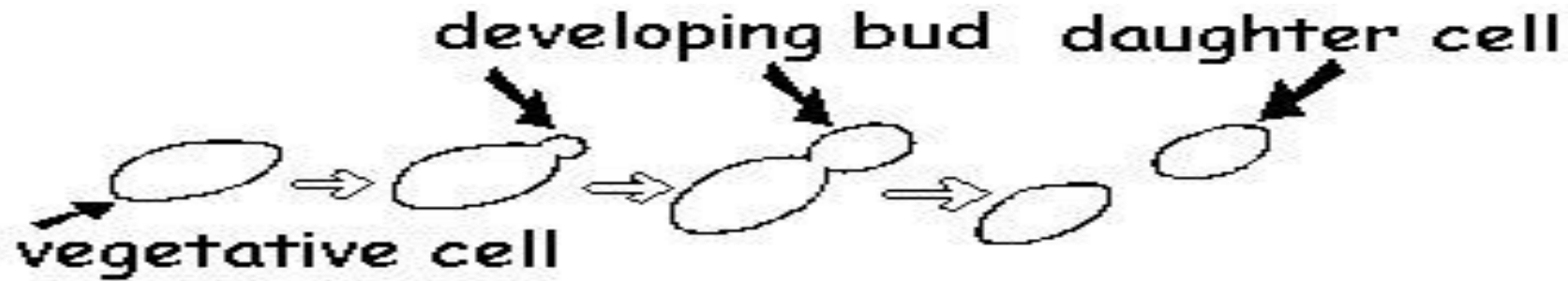
Taphrina deformans (Peach Leaf Curl)

- Budding spores infect the peach leaf (m) producing more buds or mycelia, which penetrate the leaf tissue.
- The host tissue reacts to this infection by forming swollen, tumor-like masses (n) and by tortuous curling of the leaves.

Reproduction in Yeast

- Yeasts - unicellular true fungi
- Used in a variety of commercially important fermentation processes (e.g. bread-making, brewing beers and wines)
- Capable of reproducing asexually and sexually
- Yeasts reproduce asexually by either:
 1. BUDDING (e.g. *Saccharomyces cerevisiae*)
 2. BINARY FISSION (splitting into two equal halves; e.g. *Schizosaccharomyces pombe*)

Reproduction in Yeast



2. Class – Plectomycetes

- Production of closed fruiting bodies (Cleistothecia)
- The majority members are saprobes found in soil and on plant/animal debris like wood, dung, hair, feather, horns etc.
- Few are parasitic causing diseases like dermatomycosis and aspergilosis
- Economically important for production of citric acid, gluconic acid, penicillin griseofulvin
- Responsible for food, leather, textile and plastic spoilage

1. Order Onygenales

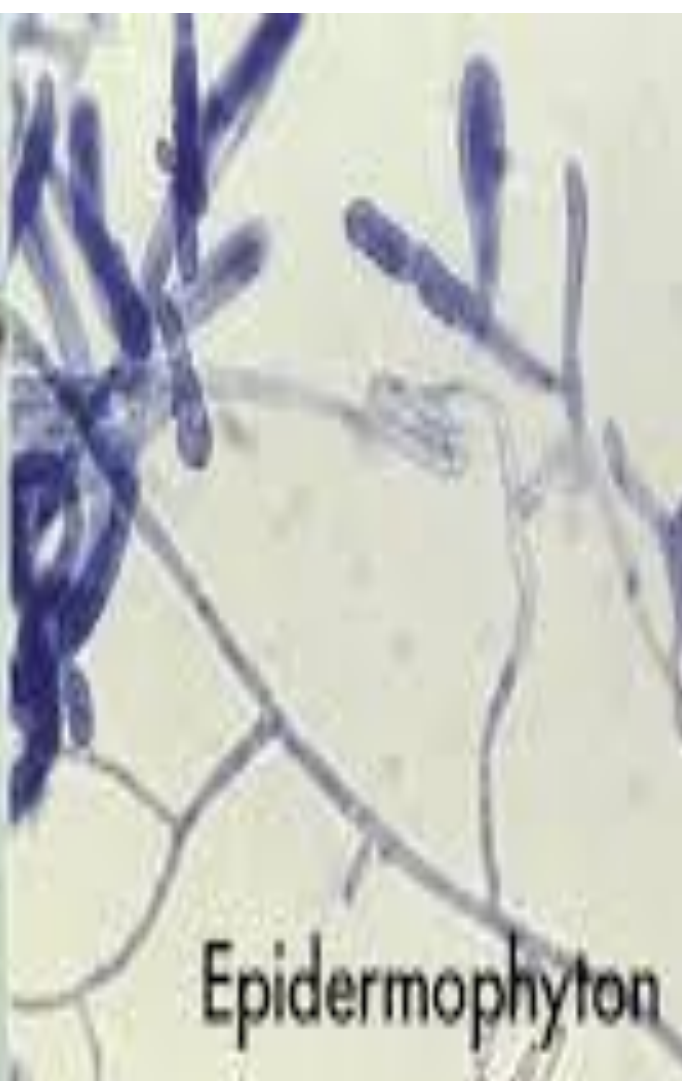
- Most of them have ability to degrade keratin and found associated with wool, hair, feather and skin (Keratinophilic)
- The members are called dermatophytes

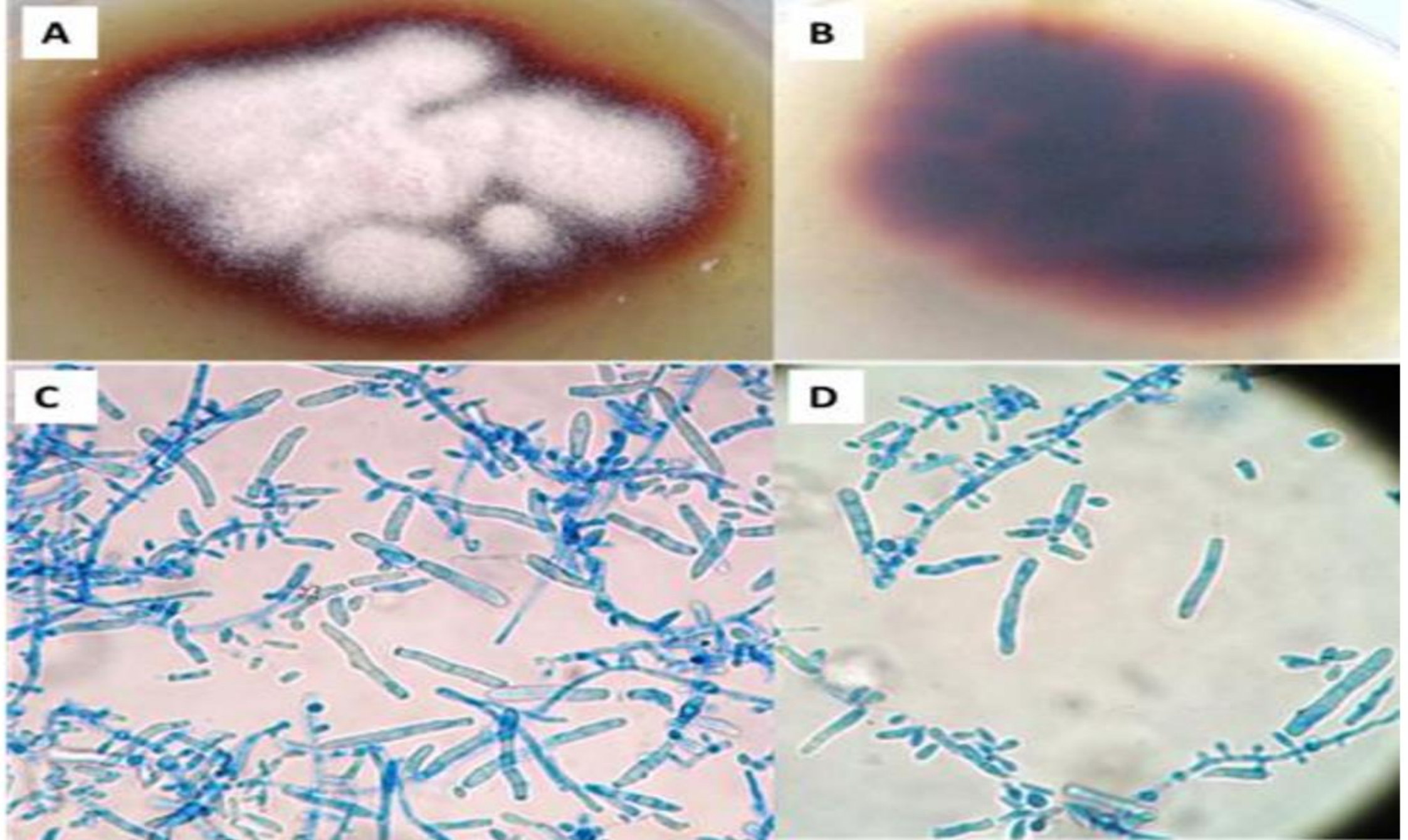
Examples : *Arthroderma*, *Trichophyton*, *Microsporum*, *Chrysosporium*

- various skin diseases caused by dermatophytes are medically known as ringworms or tinea

| Disease | Causal organism |
|------------------------------------|---|
| Body ringworm (Tinea corporis) | Trichophyton mentagrophytes, Microsporum sp. |
| Jock itch (Tinea cruris) | Trichophyton mentagrophytes, T. rubrum, Epidermophyton sp. |
| Scalp ringworm (Tinea capitis) | Mycrosporum |
| Ring worm of nails (Tinea angulum) | Trichophyton rubrum |
| Ring worm of foot (Tinea pedis) | Trichophyton mentagrophytes, T. rubrum |
| Ring worm of palm (Tinea mannum) | Trichophyton mentagrophytes |







T. rubrum var. *raubitschekii*. A: Colony on PDA after 10 days of incubation, B: Reverse of the and D: Microscopic morphological features X 400.



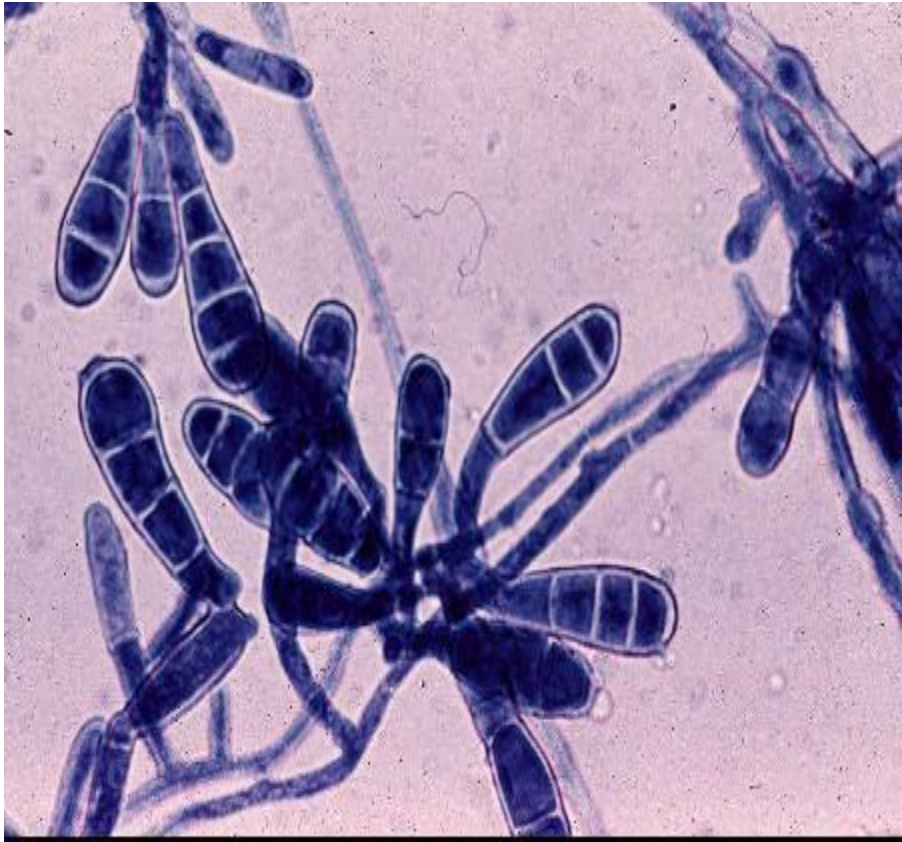
(*Microsporium* sp.)





Tinea capitis (Microsporum sp.)

Epidermophyton



Epidermophyton



2. Order Eurotiales

- **Cleistothechia with scattered asci**
- **Two stages are found Perfect – both Asexual and sexual stages**
- **Great economic importance for production of organic acids, antibiotics and fermented food**
- **Responsible for spoilage of food, textile, materials**

Examples

Common Molds

- *Aspergillus* spp. (mold on bread, leather; causes human skin and respiratory disease), *Aspergillus oryzae* is used to make sake from rice in Japan
- *Penicillium italicum* (blue mold on citrus fruits and preserves), *P. digitatum* (green mold on citrus fruits), *P. camemberti* (flavoring in Camembert cheese), *P. roqueforti* (for flavor in production of Roquefort cheese), *P. notatum* and *P. chrysogenum* (source of the antibiotic, penicillin)

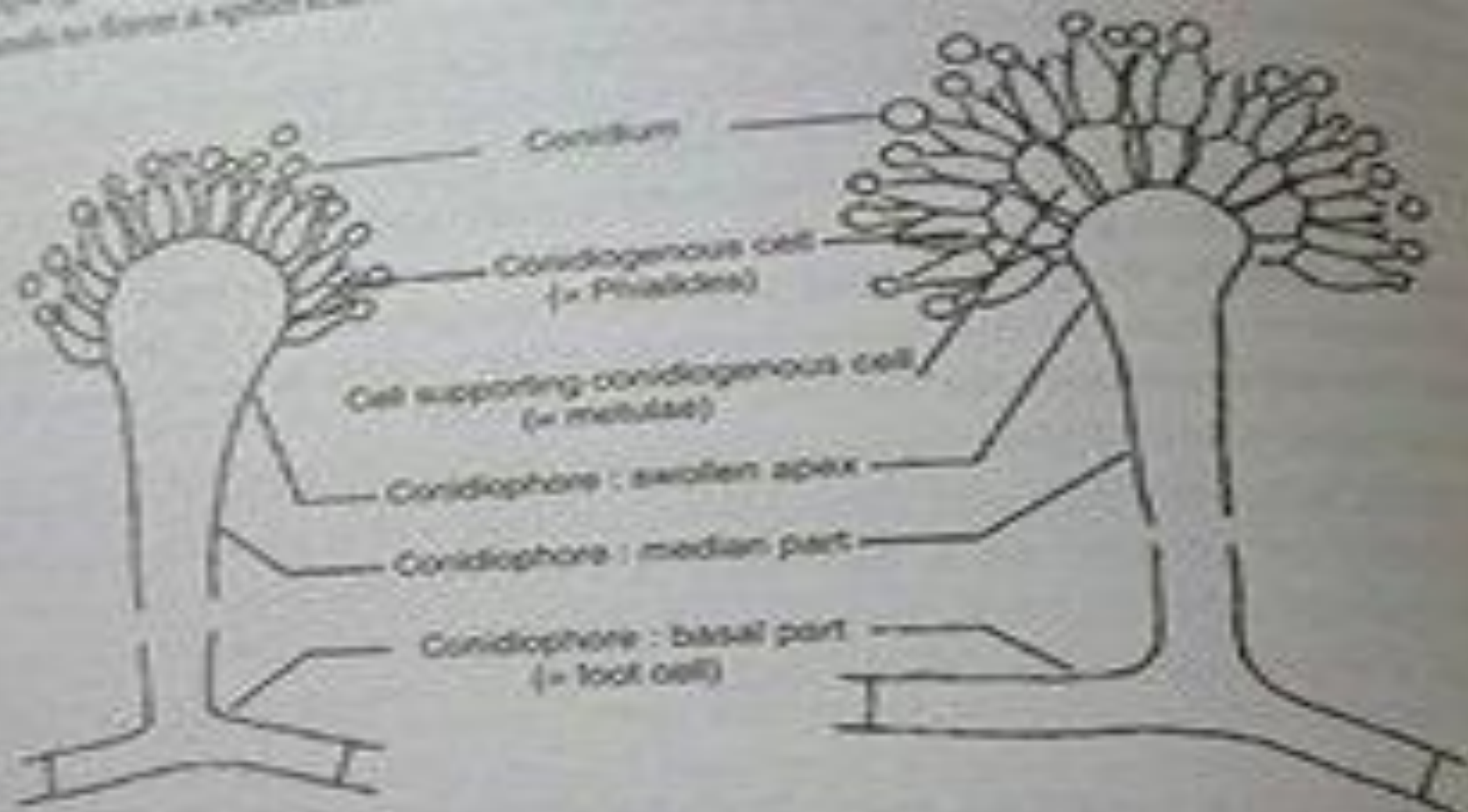


Fig 11.5. *Aspergillus*. Terms recommended to describe the different conical structures (Modified from Kirk et al., 2001).

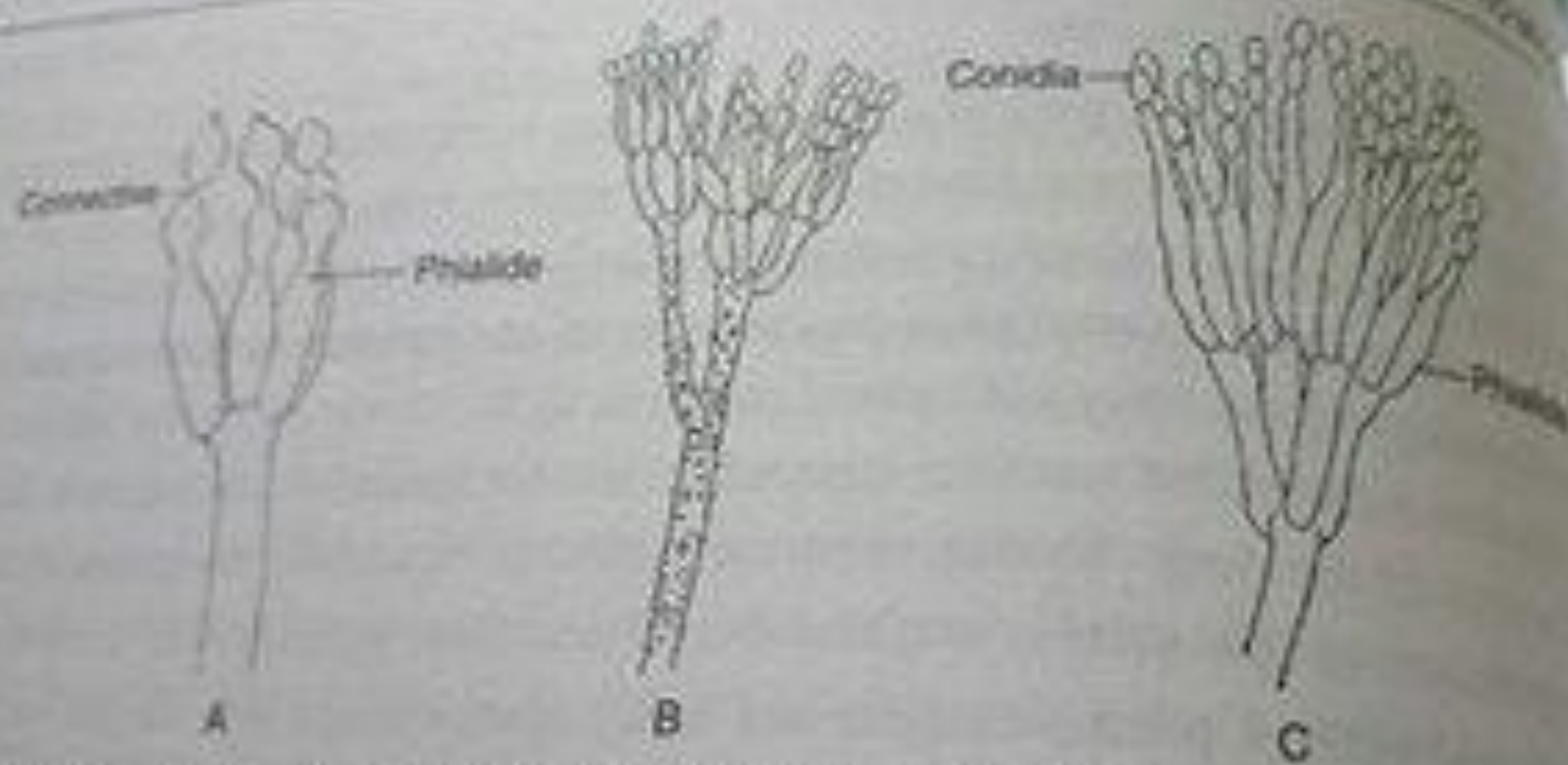


Fig. 11.8. *Penicillium*. Three types of conidial apparatus. (A) Conidiophore bearing conidogenous cells (monoverticillate) (*P. thomii*). (B) Conidiophore bearing phialides in asymmetrical fashion (e.g., *P. lanosco-coeruleum*). (C) Conidiophore bearing phialides in symmetrical fashion (e.g., *P. wortmannii*).

3. Class – Pyrenomycetes

- Fruit body Perithecium
- Asci typically produced on a basal hymenium layer

1. Order Erysiphales:

- Obligate biotrophic parasitic fungi of flowering plants
- Causing powdery mildews
- Mode of nutrition by haustoria of various shapes

Examples:

- *Erysiphe* – Powdery mildew of cereals and grasses
- *Podosphaera* – Powdery mildew of apple
- *Uncinula* – Powdery mildew of grapes
- *Phyllactinia* – Powdery mildew of Shisam

2. Order : Sordariales

- **Mainly saprobs**
- **Asospores with gelatin sheath and appendages**
- **Drosophila of filamentous fungi**

Example : Neurospora – Pink bread mold

3. Order: Hypocreales

- **Members produce strong alkyloids**

Example : Gibberella – source of gibberellin;

Cleviceps – ergotoxin, ergotamine

4. Class – Discomycetes

- Asci produced in an apothecium
- Prominent dung fungi
- Mostly called as coprophilous fungi or cup fungi

Example : *Peziza* – largest cup fungi, peat fungi

Morchella – morels/ guchhi/ spring mushroom

5. Class – Laboulbeniomycetes

- True mycelium absent
- Members are specialized exo parasites of arthropods, and marine red algae

6. Classes – Loculoascomycetes

- Bitunicate asci with septate ascospores
- Produced in an ascostroma(Pseudothecium)
- Mostly cellulose degraders and lichen formers
- Some members are plant pathogen

Economic Importance

Harmful interactions

One of their most harmful roles is as the agent of many plant diseases. For instance:

- Dutch Elm Disease, caused by the closely related species *Ophiostoma ulmi* and *Ophiostoma novo-ulmi*, has led to the death of many elms in Europe and North America.
- The originally Asian *Cryphonectria parasitica* is responsible for attacking Sweet Chestnuts (*Castanea sativa*), and virtually eliminated the once-widespread American Chestnut (*Castanea dentata*),
- A disease of maize (*Zea mays*), which is especially prevalent in North America, is brought about by *Cochliobolus heterostrophus*
- *Taphrina deformans* causes leaf curl of peach
- *Uncinula necator* is responsible for the disease powdery mildew, which attacks grapevines.
- Species of *Monilinia* cause brown rot of stone fruit such as peaches (*Prunus persica*) and sour cherries (*Prunus cerasus*)
- Members of the Ascomycota such as *Stachybotrys chartarum* are responsible for fading of woollen textiles, which is a common problem especially in the tropics.

- Blue-green, red and brown molds attack and spoil foodstuffs - for instance *Penicillium italicum* rots
- Cereals infected with *Fusarium graminearum* contain mycotoxins like deoxynivalenol (DON), which can lead to skin and mucous membrane lesions when eaten by pigs
- Ergot (*Claviceps purpurea*) is a direct menace to humans when it attacks wheat or rye and produces highly poisonous and carcinogenic alkaloids, causing ergotism if consumed. Symptoms include hallucinations, stomach cramp, and a burning sensation in the limbs ("Saint Anthony's Fire")
- *Aspergillus flavus* , which grows on peanuts and other hosts, generates aflatoxin, which damages the liver and is highly carcinogenic
- *Candida albicans*, a yeast that attacks the mucous membranes, can cause an infection of the mouth or vagina called thrush or candidiasis, and is also blamed for "yeast allergies"
- Fungi like *Epidermophyton* cause skin infections but are not very dangerous for people with healthy immune systems. However, if the immune system is damaged they can be life-threatening; for instance, *Pneumocystis jirovecii* is responsible for severe lung infections that occur in AIDS patients

Positive effects

On the other hand, ascus fungi have brought some important benefits to humanity

- The most famous case may be that of the mould *Penicillium chrysogenum* (formerly *Penicillium notatum*), which, probably to attack competing bacteria, produces an antibiotic that, under the name of penicillin, triggered a revolution in the treatment of bacterial infectious diseases in the 20th century.
- The medical importance of *Tolyocladium niveum* as an immunosuppressor can hardly be exaggerated. It excretes Ciclosporin, which, as well as being given during Organ transplantation to prevent rejection, is also prescribed for auto-immune diseases such as multiple sclerosis, although there is some doubt over the long-term side-effects of the treatment.
- Stilton cheese veined with *Penicillium roqueforti*
- Some ascomycete fungi can be altered relatively easily through genetic engineering procedures. They can then produce useful proteins such as insulin, human growth hormone, or TPa, which is employed to dissolve blood clots.

- Several species are common model organisms in biology, including *Saccharomyces cerevisiae*, *Schizosaccharomyces pombe*, and *Neurospora crassa*. The genomes of a number of ascomycete fungi have been fully sequenced
- Baker's Yeast (*Saccharomyces cerevisiae*) is used to make bread, beer and wine, during which process sugars such as glucose or sucrose are fermented to make ethanol and carbon dioxide
- Brewers and traditional producers of sparkling wine use both, with a primary fermentation for the alcohol and a secondary one to produce the carbon dioxide bubbles that provide the drinks with "sparkling" texture in the case of wine and the desirable foam in the case of beer
- Enzymes of *Penicillium camemberti* play a role in the manufacture of the cheeses Camembert and Brie, while those of *Penicillium roqueforti* do the same for Gorgonzola, Roquefort and Stilton
- *Aspergillus oryzae* is added to a pulp of soaked soya beans to make soy sauce
- Some members of the Ascomycota are edibles; morels (*Morchella spp.*), truffles (*Tuber spp.*), and lobster mushroom (*Hypomyces lactifluorum*)