

Classification of Fungi

Fungi are **eukaryotic** organisms that include microorganisms such as yeasts, molds, and mushrooms. These organisms are classified under the Kingdom Fungi.

Classification of Fungi

I. Depending on cell morphology

1. Yeasts
2. Yeast like fungi
3. Molds
4. Dimorphic fungi

1. Yeasts

Unicellular fungi which reproduce by budding.

On culture - produce smooth, creamy colonies

e. g. *Cryptococcus neoformans* (capsulated yeast)

2. Yeast like fungi

Grow partly as yeasts and partly as elongated cells resembling hyphae which are called pseudohyphae. e.g., *Candida albicans*

3. Molds/ Filamentous fungi

Form true mycelia & reproduce by formation of different types of spores.

Vegetative/ aerial hyphae. e.g., *Rhizopus*, *Mucor*

4. Dimorphic fungi

Occur in 2 forms

Molds (Filaments) – 25°C (soil), Yeasts – 37°C (in host tissue)

Most fungi causing systemic infections are dimorphic:

Histoplasma capsulatum

Blastomyces dermatidis

Paracoccidioides brasiliensis

Coccidioides immitis

Penicillium marneffeii

Sporothrix schenckii

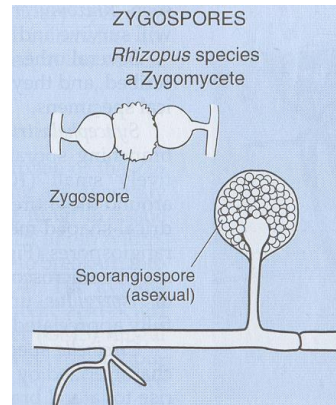
II. Systematic classification - Based on spore formation: 4 classes

1. *Phycomycetes/Zygomycetes*
2. *Ascomycetes (Sac fungi)* (Reproduce sexually)
3. *Basidiomycetes (Club fungi)*
4. *Deuteromycetes (fungi imperfecti)*

1. Class *Phycomycetes / Zygomycetes* (Conjugated fungi-Zygosporangium)

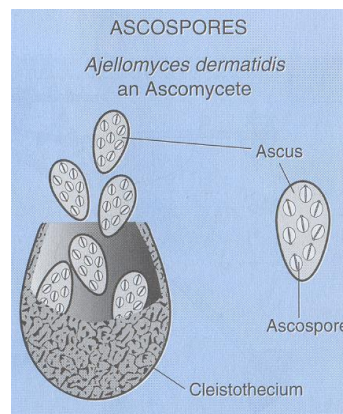
- The *Phycomycetes* are the most primitive class of fungi.
- They produce broad, aseptate hyphae and reproduce asexually by forming sporangia that contain sporangiospores.
- Sexual reproduction occurs by means of thick-walled resting spores, which can be zygospores or oospores.
- Sexual spores - **Zygosporangium**: a resting, thick-walled cell in between hyphae
Oospore a thick-walled sexual spore that develops from a fertilized oosphere in fungi.
e.g., Rhizopus, Mucor

Chytridiomycota (chytrids) are considered the most primitive group of fungi. They are mostly aquatic, and their gametes are the only fungal cells known to have flagella.



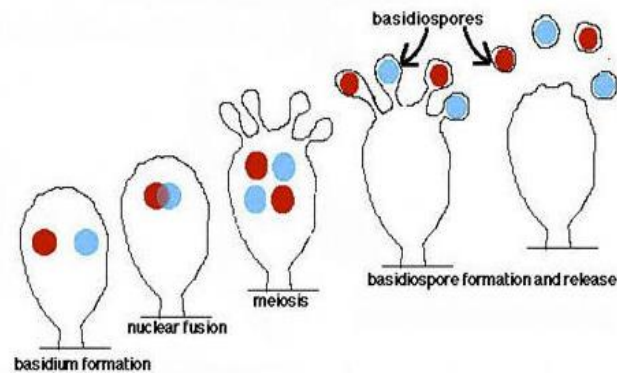
2. Class Ascomycetes

- *Ascomycetes* are represented by two morphologically distinct types.
- The first type has unicellular, round or oval forms reproducing asexually by budding of blastospores.
- The perfect yeast, the genus *Saccharomyces*, represents this type. If conditions are favorable, sexual ascospores are formed.
- Four or eight ascospores develop within each sac-like enclosure called an ascus. The asci break open to release the ascospores.
- The second type of *Ascomycetes* has septate hyphae, producing filamentous forms, which reproduce asexually by spores called conidia and sexually by ascospores.
- In this type, the asci are usually enclosed within a tightly meshed network of hyphae (mycelia) called perithecium.
- Sexual spores called ascospores are present within a sac-like structure called Ascus.
- Several asci may be seen within a fruiting body as seen in *Penicillium*, *Aspergillus*.
- Each ascus has 4 to 8 ascospores. **e.g., Aspergillus, Penicillium, Candida Yeast-Saccharomyces**



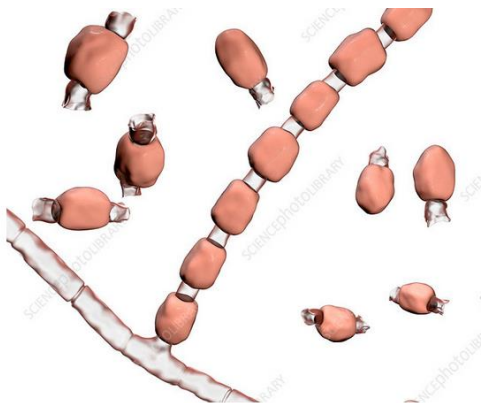
3. Class Basidiomycetes

- *Basidiomycetes* develop **sexual basidiospores** from specialized club shaped structures called **basidia**.
- Each basidium usually bears four exogenous basidiospores resembling toes on a foot.
- Sexual fusion results in the formation of a club shaped organ called base or basidium which bear spores called basidiospores. **e.g., Mushrooms, puffballs**

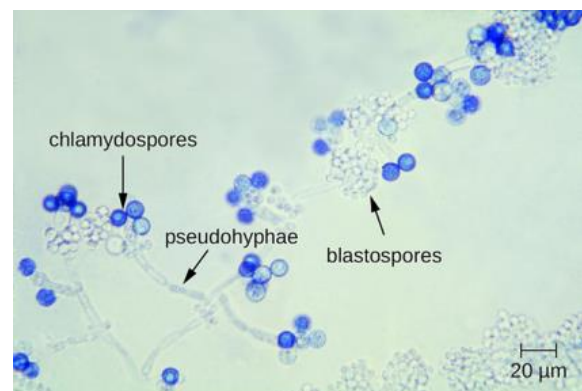


4. Class Deuteromycetes

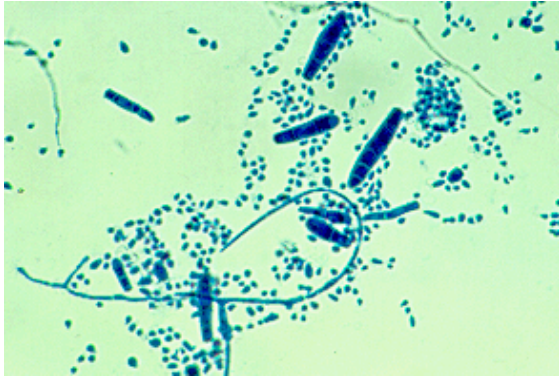
- The majority of **pathogenic fungi** belong to this class. *Deuteromycetes (fungi imperfecti)* are composed of those fungi that lack a demonstrable means of sexual reproduction and, therefore, are considered imperfect.
- The *Deuteromycetes* are represented by two morphologically distinct types: a filamentous (mold) form (25°C -soil)
- and an imperfect yeast form – (37°C in host tissue) resembling the perfect yeast, *Saccharomyces*.
- Asexual spores of two major types are produced in this class. These are the **thallospores and conidia**.
- The **Thallospore** is a spore that develops by the budding of hyphal or vegetative cells and include the **arthrospores** (formed by segmentation & condensation of hyphae), **blastospores** and **chlamydospores** (thick walled resting spores).
- The conidia are produced by abstractions from specialized hyphae called **conidiophores**.
- Large conidia may be called macroconidia and small conidia as microconidia.
e.g., Candida, Cryptococcus



Arthrospores – formed by segmentation and condensation of hyphae

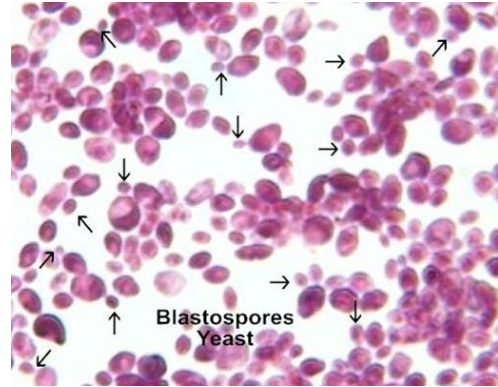


Chlamydospores – thick walled resting spores

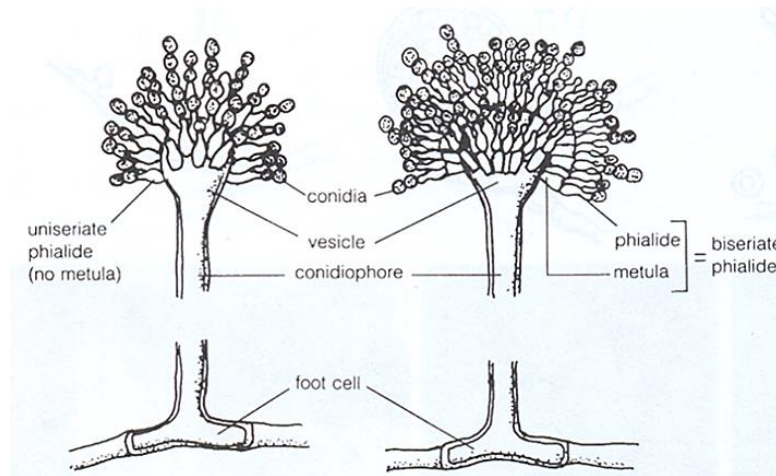


Macroconidia are large, hyaline, multiseptate, with thick rough cell walls, and are clavate, fusiform or spindle-shaped.

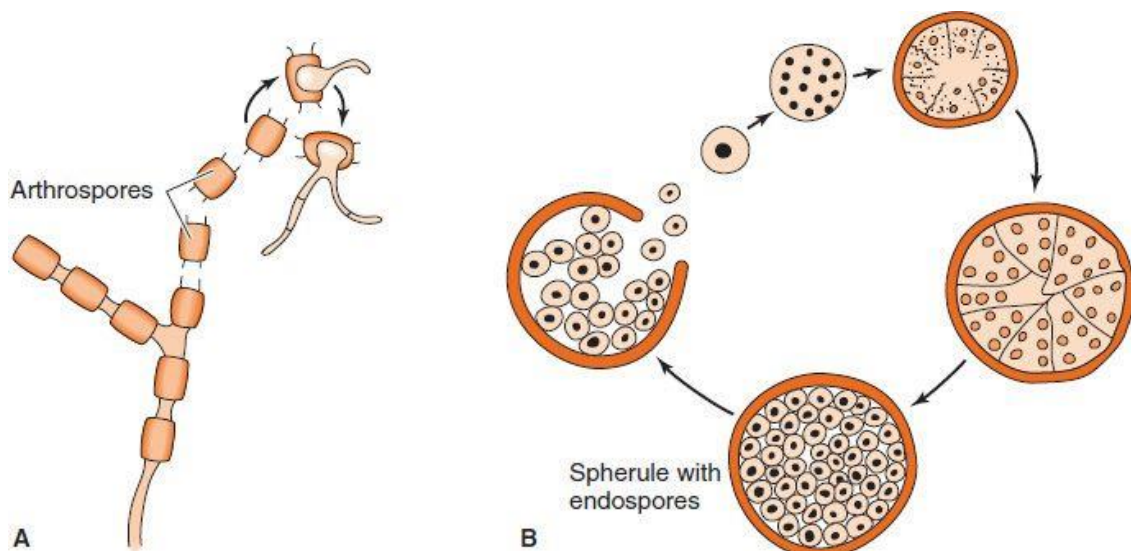
Microconidia are small **single-celled, hyaline, smooth-walled, and are predominantly clavate in shape**



Blastospores



Conidia and conidiophores



Stages of *Coccidioides immitis*. **A:** Arthrospores form at the ends of hyphae in the soil. They germinate in the soil to form new hyphae. If inhaled, the arthrospores differentiate into spherules. **B:** Endospores form within spherules in tissue. When spherules rupture, endospores disseminate and form new spherules.

(Source: <https://basicmedicalkey.com/systemic-mycoses/>)

III. Based on Mode of Nutrition

On the basis of nutrition, kingdom fungi can be classified into 3 groups.

1. **Saprophytic** – The fungi obtain their nutrition by feeding on dead organic substances. *e.g.*, *Rhizopus*, *Penicillium* and *Aspergillus*.
2. **Parasitic** – The fungi obtain their nutrition by living on other living organisms (human or animals) and absorb nutrients from their host. *e.g.*, Dermatophytes – *Trichophyton*, *Microsporum*
3. **Symbiotic** – These fungi live by having an interdependent relationship with other species in which both are mutually benefited. *e.g.*, Lichens and mycorrhiza.

Lichens are the symbiotic association between algae and fungi. Here both algae and fungi are mutually benefit as fungi provide shelter for algae and in reverse algae synthesize carbohydrates for fungi.

Mycorrhiza is the symbiotic association present between fungi and plants. Fungi improve nutrient uptake by plants, whereas, plants provide organic molecules like sugar to the fungus.

References

Caffarena, R. D., Rabaza, A., Casaux, L., Rioseco, M. M., Schild, C. O., Monesiglio, C., & Riet-Correa, F. Samanta, 2015. Veterinary Mycology, DOI 10.1007/978-81-322-2280-4_1 © Springer India

Garcia-Rubio Rocio, de Oliveira Haroldo C., Rivera Johanna, Trevijano-Contador Nuria 2020. The Fungal Cell Wall: Candida, Cryptococcus, and Aspergillus Species. *Frontiers in Microbiology*.10
URL=<https://www.frontiersin.org/articles/10.3389/fmicb.2019.02993>.
DOI=10.3389/fmicb.2019.02993.

Lehmann, P.F. (1996). Veterinary Mycology. In: Howard, D.H., Miller, J.D. (eds) Human and Animal Relationships. The Mycota, vol 6. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-662-10373-9_13

Notes by Dr. Kirtika Padalia, Department of Botany Uttarakhand Open University, Haldwani.

M. McConnaughey, in Reference Module in Biomedical Sciences, 2014. Physical Chemical Properties of Fungi.

Neil A. R. Gow, Jean-Paul Latge, Carol A. Munro. 2017. The Fungal Cell Wall: Structure, Biosynthesis, and Function, 47827,557 DOI: <https://doi.org/10.1128/microbiolspec.funk-0035-2016>

<https://basicmedicalkey.com/systemic-mycoses/>
