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2025-2026

((Mycological Taxonomy))

Stage (-3-)

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Ascomycetes

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Ascomycetes (Sac Fungi)

Ascomycota is the largest group of fungi, comprising about three-quarters of all classified fungi, with approximately 70,000 species. These fungi are widely distributed and inhabit diverse environments throughout most seasons of the year. They show considerable variability in external morphology, internal structure, and mode of nutrition. Some species are unicellular and simple, such as yeasts, while others are multicellular with large, complex fruiting structures.

Many Ascomycota species can form fruiting bodies called **ascocarps**, which may be macroscopic and take distinct shapes. Fruiting bodies may develop on the soil surface, as in cup fungi (*Cup fungi*), or underground, as in truffles (*Truffles*). Well-known members include:

- Industrial yeast (*Saccharomyces cerevisiae*)
- Penicillin-producing fungi (*Penicillium spp.*)
- Model genetic fungus (*Neurospora crassa*)
- Aflatoxin-producing fungi (*Aspergillus flavus*)
- Human pathogen (*Candida albicans*)

Ascomycota species can be saprophytic, symbiotic, or parasitic, causing numerous human, plant, and animal diseases. At the same time, many species are economically important for producing antibiotics, enzymes, organic acids, and for their nutritional value, as in truffles.

General Structure of Ascomycota

Ascomycota can be divided into two main groups:

1. **Primitive Ascomycetes (Hemiascomycetidae)** – unicellular, do not form fruiting bodies.
2. **True Ascomycetes** – multicellular, form fruiting bodies (ascocarps).

Except for yeasts and a few other species, Ascomycota have a **filamentous thallus**, composed of septate hyphae. Septa contain pores allowing nuclei to move freely between cells. Each cell usually contains one or more nuclei.

These fungi do not produce flagellated spores or spores inside specialized spore sacs, but they reproduce **asexually** by forming **conidia**, either singly or in chains, borne on **conidiophores**. Conidiophores may arise from different parts of the mycelium or from specialized structures. Unicellular yeasts may also reproduce by **budding** or **transverse fission**.

Sexual reproduction occurs via:



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- Fusion of gametangia
- Contact between gametangial structures
- Plasmogamy or zygotic conjugation

Sexual spores develop inside asci within ascocarps. These **perfect spores** (*ascospores*) usually number eight per ascus. The life cycle includes:

- **Asexual stage:** Anamorph
- **Sexual stage:** Telomorph

Asci and Ascospores

- Asci are typically rectangular, cylindrical, or oval.
- They may be **sessile** or **stalked** and can be naked or contained in a fruiting body.
- The fertile layer (**hymenium**) contains asci and sterile hyphae (**paraphyses**), which may aid in spore dispersal.
- Each ascus usually contains 8 ascospores, although numbers can vary (4, 16, 32, or more), depending on nuclear divisions. Rarely, asci can contain hundreds of nuclei, as in *Trichobolus*.

Ascospore variation:

- Shape: spherical, filamentous, or elongated
- Color: black, colorless, or pigmented
- Size: from a few microns to 1000 μm
- Cellularity: unicellular or multicellular

These features are critical for taxonomic classification.

Hymenium

The hymenium is a layer of elongated cells perpendicular to the surface of the fruiting body. It consists of asci and sterile hyphae. Asci may be **naked** (e.g., yeasts, *Taphrina*) or enclosed in a protective tissue forming an **ascocarp**.

Ascocarps (Fruiting Bodies)

In true Ascomycetes, asci and associated hyphae are embedded in a protective tissue called the **ascocarp**. There are three main types:

1. **Cleistothecia (closed ascocarps):**



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- Spherical, no opening
- Asci are scattered inside; spores are released when the wall decays (e.g., *Eurotium*)
- 2. **Perithecia (flask-shaped ascocarps):**
 - Pear- or flask-shaped with a narrow opening (**ostiole**)
 - Asci arranged parallel inside (e.g., *Claviceps*)
- 3. **Apothecia (open, cup-shaped):**
 - Cup- or disk-shaped with vertical layer of asci
 - Asci often arranged in parallel on surface (e.g., *Peziza*)

Some species have **naked asci** not enclosed in ascocarps (*Taphrina*).

Ascus Formation

- Ascocarps contain fertile hyphae (haploid, n) with male and female genetic traits.
- Dikaryotic (n+n) hyphae form via **plasmogamy** without nuclear fusion (**karyogamy**).
- Sexual reproduction involves **ascogonium** (female) and **antheridium** (male), connected by **trichogyne** for nuclear transfer.
- Dikaryotic hyphae form **croziers (hooks)** at tips; nuclei fuse in the ascus mother cell to form diploid nucleus.
- Meiotic divisions yield 4 nuclei, followed by mitosis to produce **8 ascospores** per ascus.
- Asci develop among sterile hyphae (**paraphyses**) to form mature ascocarp.

Ascus wall types:

- **Bitunicate:** double-walled
- **Unitunicate:** single-walled

Classification Criteria

- Presence of naked vs. enclosed asci
- Ascocarp morphology: closed, flask-shaped, open, or absent
- Color of ascocarp, asci, and ascospores
- Arrangement of asci: scattered or regular
- Wall structure of asci and ascocarp
- Location and mechanism of spore release
- Presence of sterile hyphae or pseudoparaphyses

Subclass: Hemiascomycetidae (Primitive Ascomycetes)



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- Mostly unicellular; some may have rudimentary hyphae
- Usually saprophytic; some are parasitic on plants or animals
- Lack fruiting bodies; asci are **naked**
- Includes orders: **Endomycetales** and **Taphrinales**

Order: Endomycetales

- Mostly unicellular; few with mycelium
 - Asci spindle- or crescent-shaped, rarely needle-like
 - Families: 6; genera: 45; species: ~150
 - Includes **Saccharomycetaceae**, the yeast family
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Yeasts (True Yeasts)

- Unicellular fungi, sometimes forming chains or **pseudomycelium**
- Can be saprophytic, symbiotic, or parasitic
- Industrially important for fermentation, single-cell protein, and food production
- **Saccharomyces** is the most important genus (~41 species), discovered by Robert Hooke in 1680
- **S. cerevisiae**: used in baking and brewing; converts sugars into ethanol and CO₂

Cell structure:

- Cell wall: proteins, lipids, glucans, mannans, sometimes chitin
 - Cytoplasm: mitochondria, ER, stored nutrients (glycogen, lipids)
 - Nucleus: single, spherical or oval
 - Vacuole: large, with membrane-bound inclusions
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Yeast Reproduction

1. Asexual

- **Budding**: small outgrowth forms, nucleus divides, bud detaches leaving **bud scar**
- **Transverse fission**: cell elongates, nucleus divides, then separates (*Schizosaccharomyces*)
- **Endospore formation**: cytoplasm divides into 4–8 internal spores

2. Sexual

- Occurs under nutrient limitation, rarely
- Fusion of haploid cells or spores (*isogamy* or *heterogamy*)



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- Formation of diploid nucleus → meiosis → 4–8 ascospores
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Economic Importance of Yeasts

Benefits:

1. Alcoholic fermentation: converts glucose/fructose → ethanol + CO₂ + energy
2. Treats certain skin and intestinal diseases
3. Vitamin production (B, G, C) under UV exposure
4. Baking: CO₂ production makes bread light and porous

Harms:

1. Spoilage of cheeses, tomatoes, and related products
2. Plant diseases: cotton, wheat, tomatoes, beans, hazelnuts
3. Human diseases:
 - *Candida glabrata* (Torulopsis, Blastomycosis): skin, nervous system infections
 - *Candida vaginilli*: vaginal inflammation
 - *Cryptococcus neoformans*: neurological disorders (cryptococcosis)
 - *Candida albicans*: moniliasis affecting mucous membranes, skin, and lungs



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