16. Morphology of fungi – economic importance

A **fungus** is the group of eukaryotic microorganisms lack of chlorophyll that includes unicellular microorganisms such as yeasts and molds, as well as multicellular fungi that produce familiar fruiting forms known as mushrooms. Fungi cell walls contain chitin, unlike the cell walls of plants, bacteria and some protists. Similar to animals, fungi are heterotrophs, that is, they acquire their food by absorbing dissolved molecules, typically by secreting digestive enzymes into their environment. Growth is their means of mobility, except for spores, which may travel through the air or water (a few of which are flagellated). Fungi are the principal decomposers in ecological systems.

Characteristics of fungi

size ranges from 5 – 10 µm and consist of both unicellular (yeast) and multicellular (mushroom) organisms

- Fungal cells contain membrane-bound nuclei with chromosomes that contain DNA with noncoding regions called introns and coding regions called exons. Fungi have membrane-bound cytoplasmic organelles such as mitochondria, sterol-containing membranes, and ribosomes of the 80S type.
- They have a characteristic range of soluble carbohydrates and storage compounds, including sugar alcohols and polysaccharides
- Fungi lack chloroplasts and are heterotrophic organisms and so require preformed organic compounds as energy sources. Hence it is a saprophytic nature (derive food through dead organic matter)
- Parasitic :-Some fungi are parasites, living in or on another organism (called a host) from which they obtain their nutrients. This relationship usually harms the host. Such parasitic fungi usually have specialized tissues called haustoria that penetrate the host's body for food absorption.
- Symbionts :- Some fungi live in a mutually beneficial symbiotic relationship with another organism.
    - Lichen (association of fungi + algae)Some fungi are associated with either cynobacteria or green algae and this type of symbiotic associations is known as lichen.
    - Mycorrhizae (fungi + plants) :- Some fungi are most often associated with the roots of some plant species, and this type of symbiotic associations is known as mycorrhizae.Mutualistic association of plant roots and fungi increase the absorptive surface area of plant roots. (Fungus gets organic nutrients from plant; Plant gets minerals from the soil via the fungus).
- Fungi have a cell wall made of **Chitin** – polymer of N-acetyl glucosamine and vacuoles, do not contain cellulose
- They reproduce by both sexual and asexual means
- The cells of most fungi grow as tubular, elongated, and thread-like (filamentous) structures called hyphae, which may contain multiple nuclei and extend by growing at their tips. Each tip contains a set of aggregated vesicles—cellular structures consisting of proteins, lipids, and other organic molecules—called the Spitzenkörper.
- Both fungi and oomycetes grow as filamentous hyphal cells.
- more than 70 fungal species display bioluminescence.
- Some species grow as unicellular yeasts that reproduce by budding or binary fission. Dimorphic fungi can switch between a yeast phase and a hyphal phase in response to environmental conditions.

- Fungi grow better at a pH of 5, which is too acidic for most bacteria.
- Almost all molds are aerobic. Most yeasts are facultative anaerobes.
- More resistant to high osmotic pressure than bacteria.
- Can grow on substances with very low moisture.
- Fungi require less nitrogen than bacteria to grow.
- Food storage generally in the form of lipids and glycogen.
- All fungi require water and oxygen (no obligate anaerobes).

Nutrition :
Fungi are heterotrophic because these lack chlorophyll (green pigment) and thus cannot create their own food through photosynthesis. Fungi acquire their nutrients from dead organic matter by secretion of extracellular enzymes followed by absorption.

Morphology of fungi

Microscopic structures

Most fungi grow as hyphae, which are cylindrical, thread-like structures 2–10 µm in diameter and up to several centimeters in length. Hyphae grow at their tips (apices); new hyphae are typically formed by emergence of new tips along existing hyphae by a process called *branching*, or occasionally growing hyphal tips fork, giving rise to two parallel-growing hyphae.

The combination of apical growth and branching/forking leads to the development of a mycelium, an interconnected network of hyphae.

Hyphae can be either septate or coenocytic.

Septate hyphae are divided into compartments separated by cross walls (internal cell walls, called septa, that are formed at right angles to the cell wall giving the hypha its shape), with each compartment containing one or more nuclei; coenocytic hyphae are not compartmentalized.

Septa have pores that allow cytoplasm, organelles, and sometimes nuclei to pass through; an example is the dolipore septum in fungi of the phylum Basidiomycota.

Coenocytic hyphae are in essence multinucleate supercells.

Many species have developed specialized hyphal structures for nutrient uptake from living hosts; examples include haustoria in plant-parasitic species of most fungal phyla, and

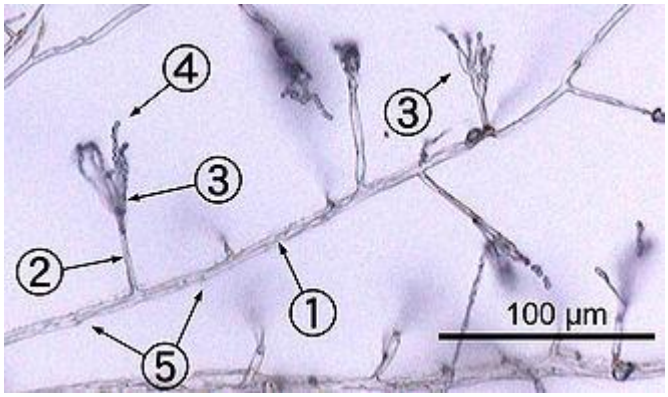
arbuscules of several mycorrhizal fungi, which penetrate into the host cells to consume nutrients.

Fungi are unusual among the eukaryotes in having a cell wall that, in addition to glucans (e.g., β-1,3-glucan) and other typical components, also contains the biopolymer chitin.

In the **Basidiomycetes**, the spores are produced **externally**, on the end of specialised cells called **basidia**.

In **Ascomycetes**, spores are produced **internally**, inside a sac called an **ascus**.

Asci and basidia are both **microscopic** structures.



Penicillium sp

1. hypha
2. conidiophore
3. phialide
4. conidia
5. septa

Macroscopic structures

Fungal mycelia can become visible to the naked eye, for example, on various surfaces and substrates, such as damp walls and spoiled food, where they are commonly called molds. Mycelia grown on solid agar media in laboratory petri dishes are usually referred to as colonies. These colonies can exhibit growth shapes and colors (due to spores or pigmentation) that can be used as diagnostic features in the identification of species or groups. Some individual fungal colonies can reach extraordinary dimensions and ages as in the case of a clonal colony of *Armillaria solidipes*, which extends over an area of more than 900 ha (3.5 square miles), with an estimated age of nearly 9,000 years.

The apothecium—a specialized structure important in sexual reproduction in the ascomycetes—is a cup-shaped fruit body that holds the hymenium, a layer of tissue containing the spore-bearing cells. The fruit bodies of the basidiomycetes (basidiocarps) and some ascomycetes can sometimes grow very large, and many are well known as mushrooms.

Economic importance

Importance :

- Cause plant diseases; few animal and human diseases too
  Some fungi are parasitic on humans, animals, and plants. In humans, they can cause ringworm, athlete's foot, and other skin diseases. Certain fungi may be caused for Wilting of crops like tomato, corn, banana, and papaya. Fungi may also attack seeds. Consequently, these seeds don't germinate.

- Decomposition of organic matter in the soil and nutrient cycle

Wood rotting fungi because fungi obtain their nutrition from organic matter, they grow wherever organic matter is present recycle nutrients from dead matter

Mycorrhzae fungi grow into roots of most plants and supply phosphorous and water. 90% of plants require this growth of fungi on their roots in order to survive actually is a problem with refo restation of barren land because the fungi are not present

symbiosis between the fungus and the plantfungus gets sugars from plant and fungus provides phosphorus and water to the
plant

- Food spoilage

  Mycotoxins are toxic chemicals produced by fungi which accumulate in infected food
  e.g.:
  i) corn or peanuts contaminated with aflatoxins. Aspergillus fungi grow on corn or peanuts and make one of the most potent carcinogens known aflatoxins.

ii) Ergot of rye : a fungus infects the flowers of the rye plant and produces fungal structures in the seed head which are harvested with the rye seed.

Eating the Ergot infected rye are poisoned by compounds produced in the fungus structure called Ergotism or St. Anthony's Fire nervous spasms, onvulsions, psychotic delusions, constriction of blood vessels that lead to tingling in arms and legs and possibly gangrene

- industrial importance : Saccharomyces cerevisiae

Used to make bread and wine. Genetically engineered yeast strains are used to make proteins (Hepatitis B vaccine).

Taxomyces Produces anticancer drug taxol.

Trichoderma Produces cellulase.

Biocontrol : Trichoderma

Yeast fermentation. Yeast breaks down sugars to produce ethyl alcohol and carbon dioxide (CO_2)

brewing of alchoholic beverages: beer , wineyeast turns sugars in grains or grapes into ethyl alcohol (and carbon dioxide bubbles)

bread making where yeast turns sugars into alchohol and carbon dioxide, produces bubbles that rise the dough

Cheese production: Types of cheeses blue cheeses such as Roquefort, Stilton, and Camembert

- Antibiotic industry

  Life saving antibiotic can produce from different fungi. Penicillin produces from Penicillium notatum. Sir Alexander Fleeming was discovered Penicillin in 1928.

- Used as food (mushroom)

  Mushrooms are another kind of fungi. Some mushroom species are edible and others are poisonous. Nowadays, edible mushrooms such as Volvariella sp. are commonly grown. Ipil-ipil leaves, rice stalks, and banana leaves are used as growing surfaces. To these substrates, honey, coconut water, and urea may be added.

Commercial uses