Ecology and Fungal Physiology

LECTURE- 2 **Dr. Hebba Al-Lami**

1- Fungal Morphology

A- Filamentous Fungi

Filamentous fungi composed of aggregated long, branching threads termed hyphae (singular: hypha), organized to support spores for reproduction and dissemination. The hyphae extend and branch forming a network, termed a mycelium, from which the apically growing hyphae seek out, exploit, and translocate available nutrients. Apically growing hyphae usually have a relatively constant diameter ranging from 1 to 30 μm or more, depending on fungal species and growth conditions.

Some other structures:

* Rhizomorphs or cords: linear aggregations of parallel-oriented hyphae, composed of wide, empty vessel hyphae, thier function is to explore for and translocate water and nutrients to or from a particular site. These structures are common among Ascomycota and Basidiomycota.

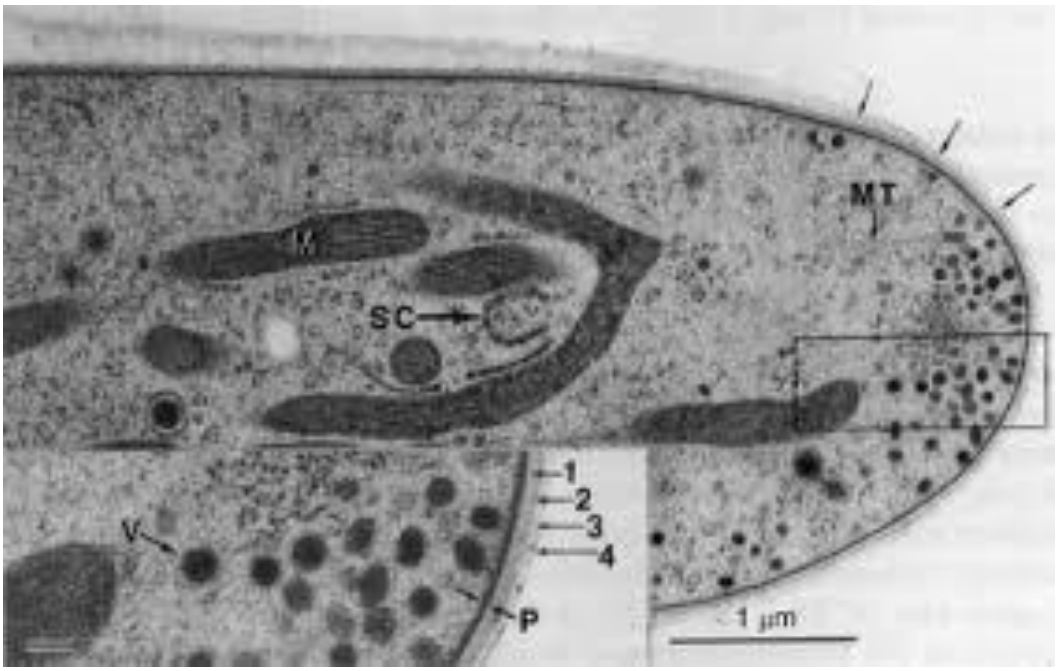

Figure 1 Transmission electron microscopy of ultrathin sections of a hyphal tip of Fusarium reveals intracellular fine structure. Layers of cell wall are shown in greater detail in lower image. M, Mitochondrion; V, vesicles; P, plasma membrane; MT, microtubules; SC, smooth Golgi cisternae; 1, 2, 3, 4, four layers of the cell wall. The Spitzenkörper appears as a region surrounded by vesicles containing many small particles (rectangle).

B- Yeasts

Yeasts are unicellular (mostly Ascomycete, Basidiomycete, or members of the Deuteromycete group) fungi that divide asexually by budding or fission, The morphology of agar-grown yeasts shows great diversity in terms of color, texture, and geometry (peripheries, contours) of giant colonies. Several yeasts are pigmented and the following colors may be visualized in surface-grown colonies: cream (e.g. *Saccharomyces cerevisiae*); white (e.g. *Geotrichum candidum*); black (e.g. *Aureobasidium pullulans*); pink (e.g. *Phaffia rhodozyma*); red

(e.g. *Rhodotorula rubra*); orange (e.g. *Rhodosporidium* spp.), and yellow (e.g. *Cryptococcus laurentii*). The diversity in terms of yeast cell shapes demonstrated in (Table 1)

Table 1 Diversity of yeast cell shapes.

Cell shape	Description	Examples of yeast genera
Ellipsoid	Ovoid-shaped	*Saccharomyces*
Cylindrical	Elongated cells with hemispherical ends S	*Schizosaccharomyces*
Apiculate	Lemon-shaped	*Hanseniaspora, Saccharomycodes*
Ogival	Elongated cell, rounded at one end and pointed at other	*Dekkera, Brettanomyces*
Flask-shaped	Cells divide by bud-fission	*Pityrosporum*
Miscellaneous shapes	Triangular	*Trigonopsis*
	Curved	*Cryptococcus* (e.g. *C. cereanus*)
	Spherical	*Debaryomyces*
	Stalked	*Sterigmatomyces*
Pseudohyphal	Chains of budding yeast cells which have elongated without detachment	*Candida* (e.g. *C. albicans*)
Hyphal	Branched or unbranched filamentous cells which form from germ tubes. Septa may be laid down by the continuously extending hyphal tip. Hyphae may give rise to blastospores	*Candida albicans*
Dimorphic	Yeasts that grow vegetatively in either yeast or filamentous (hyphal or pseudohyphal) form	Candida albicans, Saccharomycopsis fibuligera, Kluyveromyces marxianus, Malassezia furfur, Yarrowia lipolytica, Histoplasma capsulatum

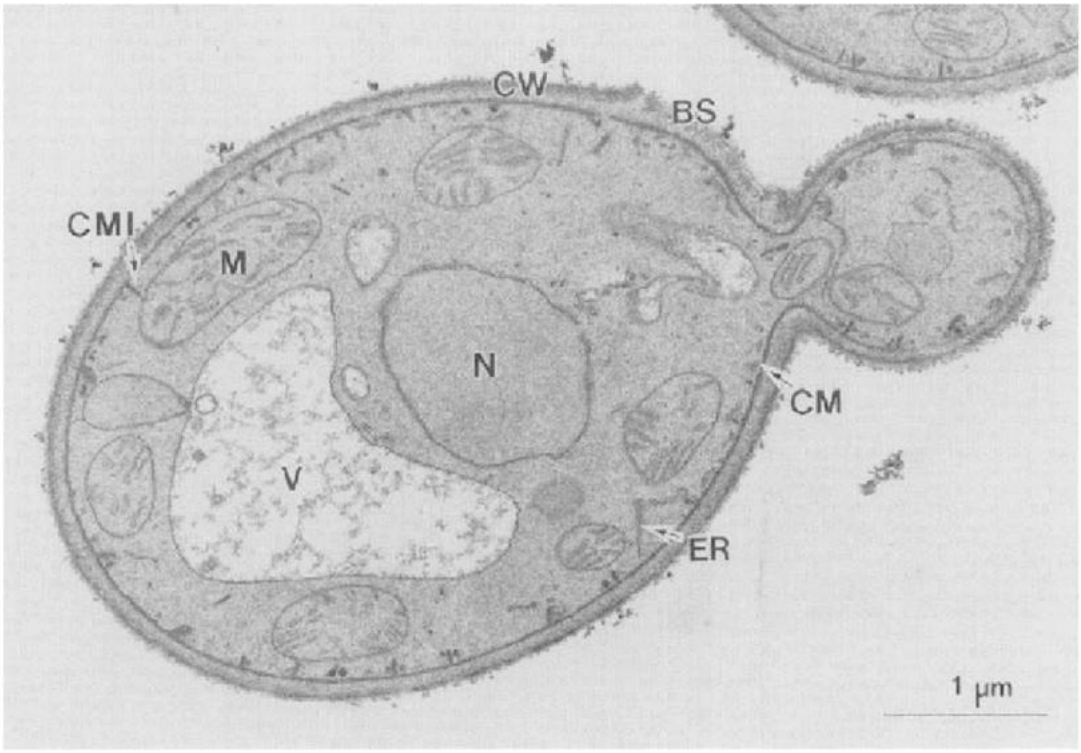

Figure 1.4: Electron micrograph of a typical yeast cell. CW, Cell wall; CM, cell membrane; CMI, cell membrane invagination; BS, bud scar; M, mitochondrion, N, nucleus; V, vacuole; ER, endoplasmic reticulum.

* Fungal dimorphism:

Adopt either the hyphal or unicellular yeast forms according to environmental circumstances. For example, Mucor sp. coenocytic hyphal fungi with O2 and spherical, multipolar budding yeasts without O2; certain important human and animal pathogens, *Candida albicans*, exist as yeast forms mobilized in body fluids but are able to form hyphae or pseudohyphae for tissue invasion.

2- Ultrastructure and Function of Fungal Cells

A- The fungal cell surface.

- Plasma membrane: is a phospholipid bilayer interspersed with globular proteins. Ergosterol is the major sterol found in the membranes of fungi, in contrast to the cholesterol found in the membranes of animals and phytosterols in plants. This distinction is exploited during the use of certain antifungal agents used to treat some fungal infections, and can be used as an assay tool to quantify fungal growth.
- The periplasm, or periplasmic space: is the region external to the plasma membrane and internal to the cell wall. In yeast cells, it comprises secreted proteins (mannoproteins) and enzymes (such as invertase and acid phosphatase) that are unable to traverse the cell wall. In filamentous fungi, the cell membrane and wall may be intimately bound as hyphae are often resistant to plasmolysis.
- Cell wall: a thick, complex fibrillar network, composed of different polysaccharides according to taxonomic group [chitin, glucans, mannoproteins, chitosan, polyglucuronic acid, or cellulose (absent from true fungi)], together with smaller quantities of proteins and glycoproteins.
- Extracellular structural components: several extramural layers may exist, including fimbriae and capsules. **Fungal fimbriae** are long, protein-containing protrusions appearing from the cell wall of certain basidiomycetous and ascomycetous fungi that are involved in cell–cell conjugation. **Capsules** are extracellular polysaccharide-containing structures found in basidiomycetous fungi. **Polymer pullulan** is an

extrahyphal substance, the, is produced commercially from *Aureobasidium pullulans*, and is used in the production of oral hygiene products.

B - Subcellular architecture and organelle function

Table 2 Functional components of an idealized fungal cell.

Organelle or cellular structure	Function
Cell envelope	Comprising: the plasma membrane which acts as a selectively permeable barrier for transport of hydrophilic molecules in and out of fungal cells; the periplasm containing proteins and enzymes unable to permeate the cell wall; the cell wall which provides protection and shape, and is involved in cell–cell interactions, signal reception, and specialized enzyme activities; fimbriae involved in sexual conjugation; capsules to protect cells from dehydration and immune cell attack
Nucleus	Relatively small. Containing chromosomes (DNA–protein complexes) that pass genetic information to daughter cells at cell division and the nucleolus which is the site of ribosomal RNA transcription and processing
Mitochondria	Site of respiratory metabolism under aerobic conditions, and, under anaerobic conditions, for fatty acid, sterol, and amino acid metabolism
Endoplasmic reticulum	Ribosomes on the rough ER are the sites of protein biosynthesis
Proteasome	Multi-subunit protease complexes involved in regulating protein turnover
Golgi apparatus and vesicles	Secretory system for import (endocytosis) and export (exocytosis) of proteins
Vacuole	Intracellular reservoir (amino acids, polyphosphate, metal ions); proteolysis; protein trafficking; control of cellular pH. In filamentous fungi, tubular vacuoles transport materials bidirectionally along hyphae.
Peroxisome	Oxidative utilization of specific carbon and nitrogen sources (contain catalase, oxidases). Glyoxysomes contain enzymes of the glyoxylate cycle

- Spitzenkörper, the apical vesicle cluster or centre, or apical body: contains differently sized vesicles derived from Golgi bodies, either large vesicles or microvesicles (chitosomes). It orientates to the side as the direction of tip growth changes, and

disappears when growth ceases. It's involved in wall extension and hence tip growth, branching, clamp connection formation (in Basidiomycetes), and germ tube formation.

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