Fungal cell Structure and Function

Overview of the Hypha:

- The hypha is a rigid tube containing cytoplasm Growth occurs at the tips of hyphae. Behind the tip, the cell is aging.

- Many hyphae possess septa Septa contains pores through which cytoplasm flows and Hyphae are actually interconnected compartments, not individual cells.
- The cell wall of hyphae are complex in structure and composition Thinner at apical (growing) end, Plasma membrane closely associated with the inner portion of the wall.

Fungal Ultrastructure:

- Zonation of organelles in hyphae
  - Hyphae show a defined polarity in the arrangement of organelles.
  - Apical tip.
- Extreme end - no organelles, but numerous membrane-bound vesicles of differing

electron densities (Golgi derived?), the cell wall is dynamic and rather ‘plastic' (site of synthesis).

- Chitin synthase is present
- Apical vesicle cluster (AVC) - Spitzenkörper
- Actin microfilaments
- Apical tip (cont.)

- Short zone following apex - no organelles, but rich in mitochondria
- Nuclei - distribution varies

- Sub-apical regions contain a diverse array of organelles, septa are present, and the cell walls are less dynamic, more rigid in structure

- **Yeast ultrastructure:**

- Typical cellular structures of a yeast include those found in other eukaryotes.
- Reproduction by budding does impact the structure of the cell wall producing.

o Bud scars on the mother cell.
o Birth scars on the newly-formed daughter cell.

Fungal Cell Wall Functions:

- Structural barrier
- Determines the pattern of cell growth and is partly dependent upon:

- Chemical composition.
- Assembly of the wall components.

- The environmental interface of the fungus

-Protects against osmotic lysis.
-Acts as a molecular sieve.
-Contains pigments for protection.

- The binding site for enzymes.
- Mediates interactions with other organis

Cell wall components:

- Two major types of components

- Structural polymers.
- polysaccharide fibrils that provide rigidity/integrity of the wall.
- Matrix components - cross-link the fibrils as well as coat/embed them.

- Main wall components differ between the major taxonomic groups of fungi.

- Chitin
- straight chain polymers of b-1,4-linked N-acetyl glucosamine residues;
- chitosan is de-acetylated chitin.
- Glucan - polymers of b-1,3-linked glucose residues with short b-1,6-linked side chains.
- Cellulose - b-1,4-linked glucans.
- Matrix polymers: Glucuronic acids, Mannoproteins - mannose attached to protein.

Wall architecture:

- Hyphae tend to have separate layers of wall components.
- Layers actually grade into one another.
- Components of one layer tend to be covalently bond to those of another.
- Subapical regions are relatively thicker than the apical region.

- Yeasts have less complex wall architecture.

Extrahyphal matrix - two types:

- Defined zone of polysaccharide - capsule
- The diffuse area outside the hyphal wall

Septa:

- Septa occur at generally regular intervals along a length of a hypha.
- Perforations allow cytoplasm to flow from one cell to another.
- When a cell is damaged, a Woronin body or coagulated cytoplasm serves a plug to prevent loss of cytoplasm.
- Coenocytic fungi are more susceptible to cellular damage .

Functions of septa :

- Structural support of the hypha.
- Enables differentiation by dividing hypha into different cells that can undergo separate modes of development.

Types of septa :

- Simple
- Dolipore

Fungal Nucleus:

- Double membrane-bound organelle ranging in size from 1-2 μm to 20-25 μm in diameter
- Unique features of the fungal nucleus

- Membrane remains intact during mitosis.
- No clear metaphase plate.
- Various types of spindle-pole bodies (microtubule-organizing centers) depending upon species.

Ploidy

-Most fungi are haploid with the number of chromosomes ranging from 6 to 20.
-Some fungi are naturally diploid -Others alternate between haploid and diploid states.

Possible reasons for haploidy:

-Multiple haploid nuclei can mask mutations.
-Advantageous mutations can be selected.

Cytoplasmic Organelles :

Plasma membrane- phospholipid bilayer:

- Involved in the uptake of nutrients.
- Anchorage for enzymes/proteins, e.g., chitin synthase, glucan synthase, etc.
- Signal transduction
- Differs in that it contains ergosterol *Site of action for certain antifungal drugs *Oomycota contain plant-like sterols

Secretory system :

- Consists of the following:

- Endoplasmic reticulum (ER).
-Golgi apparatus (or equivalent).
- different in than those found in animals, plants, and the Oomycota in that they lack cisternae.
- Membrane-bound vesicles
  - Involved in fungal tip growth
  - Commercially important in the production of extracellular products.

Chitosomes - microvesicles that are capable of synthesizing chitin
 First noted from homogenized hyphae
· Able to self-assemble
 Controversial as to whether or not they are an integral part of the plasma membrane
 Function primarily within the region of the apical tip

Vacuoles :

 Functions

-Storage -Recycling of materials -Contain proteolytic enzymes -Regulation of cellular pH -Possible role in cellular expansion/growth
 Shape

-Round -Tubular - may be involved in material transport
Endocytosis and vesicle trafficking - data is still unclear if fungi

have an endosomal system: like that found in other types of eukaryotes **Fungal Cytoskeleton**

 Cytoskeleton functions:

-Transport of organelles -Cytoplasmic streaming -Chromosome separation

 Three types of cytoskeletal filaments:

- Microtubules - composed of tubulin -Microfilaments - composed of actin - Intermediate filaments - provide tensile strength

 All play a major role in hyphal tip growth