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 contain pores through which cytoplasm flows and Hyphae are actually interconnected compartments, not individual cells.

- Cell wall of hyphae are complex in structure and composition

  Thinner at apical (growing) end , Plasma membrane closely associated with 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?), 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

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

Fungal Cell Wall

Functions

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

- Chemical composition

- Assembly of the wall components

- Environmental interface of the fungus

-Protects against osmotic lysis

-Acts as a molecular sieve

-Contains pigments for protection

- Binding site for enzymes
- Mediates interactions with other organisms

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: Glucouronic 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 apical region
- Yeasts have less complex wall architecture

Extrahyphal matrix - two types:

- Defined zone of polysaccharide - capsule
- Diffuse area outside 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 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 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 tensil strength

- All play a major role in hyphal tip growth