Candida albicans

Habitat, Morphology, Cultural Characteristics, Life Cycle, Pathogenesis, Lab Diagnosis, Treatments, Prevention and Control

Habitat of Candida albicans
- **Normal Habitat:** mucosal membranes of human and other warm-blooded animals.
- Also found in the gut, the vagina or also in the surface of the skin.
- Found in the digestive tract of birds also.
- Isolated from soil, animal, hospitals, inanimate objects, and food.
- Worldwide distribution

Morphology of Candida albicans

- Small, oval, measuring 2-4 µm in diameter.
- Yeast form, unicellular, reproduce by budding.
- Single budding of the cells may be seen.
- Both yeast and pseudo-hyphae are gram positive.
- Encapsulated and diploid, also form true hyphae.
- Polymorphic fungus (yeast and pseudohyphal form)
- Can form biofilms
- Normal condition: Yeast
- Special condition (pH, Temperature): Pseudohyphae
- 80-90% of cell wall is carbohydrate
Cultural Characteristics of Candida albicans

**SDA**

- Creamy, pasty colonies, smooth after 24-48 hours at 25-37°C
- Yeast smell (odour)

**Blood Agar**

- White creamy colored
- Foot-like extensions from the margin.

**PDA**

- Smooth creamy colonies after 24-48 hours
- Green colonies

**Life Cycle of Candida albicans**

![Diagram of the life cycle of Candida albicans](image)

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- Asexual and doesn’t perform meiosis
- Ability to grow with three distinct morphologies- yeast, pseudo-hyphae and true hyphae
- Para-sexual life cycle
- Switch between different phenotypes
- Diploid Stage → form cells → homozygous → phenotypic switch from white to mating component ‘opaque’ cells → mating of opaque cells (cell fusion) → tetraploid cells → loss of chromosomes (splitting) → Diploid State
- White form: white and rounded cells forming dome-shaped colonies
- Opaque form: opaque, elongated cells forming a flatter colony.
- Opaque form is more efficient for mating than the white form

**Pathogenesis of Candida albicans**

- Opportunistic fungal pathogen that causes candidiasis in human
- Occurs in immunocompromised peoples such as HIV infected, transplant recipients, chemotherapy patients, etc.
- Mode of transmission:
  - Mother to infant through childbirth
  - Rarely through sexual contact
  - People to people transmission in hospital settings

**Virulence Factors of Candida albicans**

1. Polymorphism
   - Yeast, pseudohyphae and hyphae
   - Hyphae is more important for infection
2. **Adhesins (Als 3 Protein)**
- Sets of glycosylphatidylinositol (GPH)-linked cell surface glycoproteins that allow it to the surfaces of microorganisms.
- Helps with biofilm formation also.

3. **Invacins (Als 3 Protein)**
- Helps with the invasion of *C. albicans* into host epithelial and endothelial cells.
- *Ssa1* codes for heat shock protein.
- Induces host cells to engulf the fungal pathogens.
- Invasion by the active penetration of *C. albicans* into host cells by involving hyphae.

4. **Biofilm Formation**
- Yeast cells → adherence → surface → development of hyphae cells → in the upper part of biofilm → leads to a more resistant mature biofilm → dispersion of yeast cell.
- *Bcr1, Tec1* and *Efg1* function as important transcriptional factors.

5. **Secreted hydrolases**
- 3 main classes of hydrolases: proteases, phospholipases and lipases.
- Helps in active penetration into host cells.
- Helps in uptake of extracellular nutrients from the environment.
- 10 proteases (*Sap 1-10*), 4 major classes (A, B, C and D) of phospholipases and lipases consist of 10 members (*LIP 1-10*).

6. **Metabolic Adaption**
- In the process of infection, it undergoes metabolic adoption such as their glycolysis, gluconeogenesis and starvation responses.
- Example: quickly switch from its glycolysis to starvation responses with the activation of glyoxylate cycle.
- Due to this, it can infect almost any organ through the blood stream.

**Stages of Infection**

1. **Colonization**
   - Epithelial adhesion
   - Nutrient acquisition

2. **Superficial Infection**
   - Epithelial penetration
   - Degradation of host protein

3. **Deep-Seated Infection**
   - Tissue penetration
   - Vascular invasion
   - Immune evasion or escape

4. **Disseminated Infection**
   - Endothelial adhesion
- Infection of other host tissues
- Activation of coagulation and blood clotting cascades.

**Types of Candidiasis**

![Image of mucosal candidiasis and cutaneous candidiasis]

**A. Mucosal Candidiasis**
- **Oral candidiasis:** mucous membrane of mouth
- **Denture related stomatitis:** mild inflammation and redness of oral mucous membrane beneath a denture.
- **Angular cheilitis:** inflammation of one or both corners of the mouth
- **Median rhomboid glossitis:** redness and loss of lingual papillae
- **Vulvovaginitis:** white lesions on the epithelial surfaces of vulva, vagina and cervix
- **Balanitis:** infection of glans penis
- **Esophageal candidiasis:** infection of esophagus painful swallowing.

**B. Cutaneous Candidiasis**
- **Candida folliculitis:** infection and inflammation of hair follicles, rash may appear as pimples.
- **Candidal intertrigo:** infection of skin located between intertriginous folds of adjacent skin.
- **Candidal paronychia:** inflammation of the nail fold.
- **Perianal candidiasis:** irritation of the skin at the exit of the rectum.
- **Chronic mucocutaneous candidiasis:** immune disorder of T cells, deficient of CMI.
- **Congenital cutaneous candidiasis**: skin condition in new born babies caused by premature rupture of membranes together with a birth canal infected with *C. albicans*.
- **Diaper candidiasis**: infection of a child’s diaper area.
- **Erosio interdigitalis blastomycetia**: characterized by an oval shaped area of macerated white skin on the web between and extending onto the sides of the fingers.
- **Candidal onychomycosis**: nail infection

C. **Systemic Candidiasis**
- Candidemia: leads of sepsis
- Disseminated candidiasis (organs)
- Endocarditis
- Gastro intestinal tract infection
- Respiratory tract infection
- Genitourinary candidiasis
- Hepatosplenic candidiasis (Chronic Disseminated Candidiasis)

**Lab Diagnosis of Candida albicans**

**Specimens:** Exudates, Tissues, Scrapings

1. **Microscopy (Scraping)**
   - Examined in wet film in 10% KOH
   - Visualization of pseudohyphae and budding yeast cells of candida
   - Gram staining: Gram positive (+ve)

2. **Culture**
   - SDA: Creamy white, smooth colonies
   - CHROMAGAR: Green colonies

3. **Identification of *C. albicans***
   - **Germ Tube Test**: produce germ tube test within 2 hours when incubated in human serum at 37°C.
   - **Chlamydospores**: produced by *C. albicans* on corn meal/rice agar at 25°C. They produces round thick walled chlamydospores borne terminally or laterally.
   - **Biochemical Tests**: Glucose and maltose fermented with acid and gas production, sucrose and lactose not fermented, Pale pink coloration in Tetrazolium reduction medium

4. **Serology**
   - Limited specificity
   - Serum antibodies and cell mediated immunity are demonstrable in most people because of life long exposure to *C. albicans*.
   - *C. albicans* antigen is a delayed hypersensitivity skin test, which is used as an indicator of functions of the CMI.
   - ELISA and RIA: detection of circulating Candidial antigen either cell wall mannan or cytoplasmic constituents.
5. 1,3-beta-D-glucan assay
- Beta-D-glucan is a component of the cell wall of fungi.
- Detected by its ability to activate factor G of the horse-shoe crab coagulation cascade.
- Highly specific and sensitive test.

6. DNA probe and PCR

Treatments of Candida albicans

1. Oral candidiasis: Nystatin, miconazole, amphotericin B.
2. Cutaneous candidiasis: Clotrimazole, econazole, ciclopirox, miconazole, ketoconazole, nystatin.
3. Systemic and oral azoles: Fluconazole, itraconazole or posaconazole.
5. Blood infections: intravenous fluconazole or an echinocandin (caspofungin)
6. Candidemia: Fluconazole and Anidulafungin

Prevention and Control of Candida albicans

- Keep healthy life style
- Good hygiene, proper nutrition, careful antibiotic use.
- Add probiotics, reduce sugar intake
- Wear cotton underwear and loose pants
- Change immediately wet clothes

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