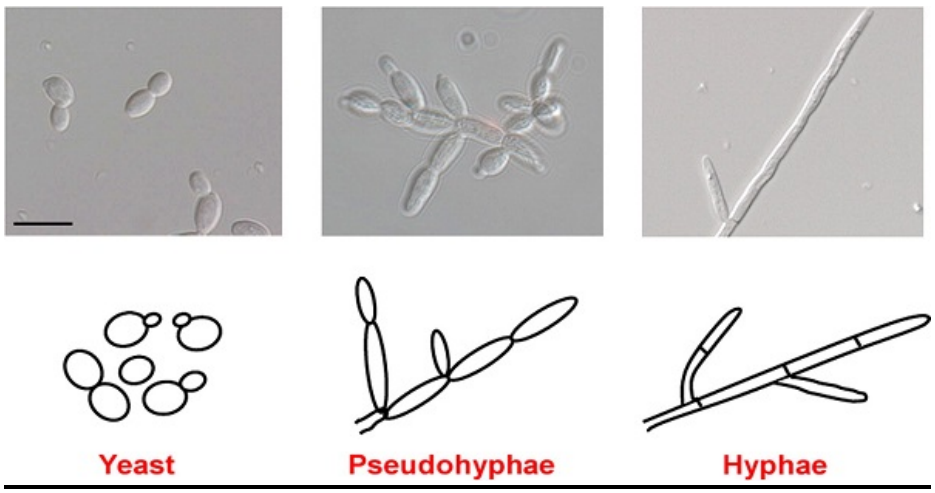
Candida albicans

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, in-animate objects and food.
- Worldwide distribution

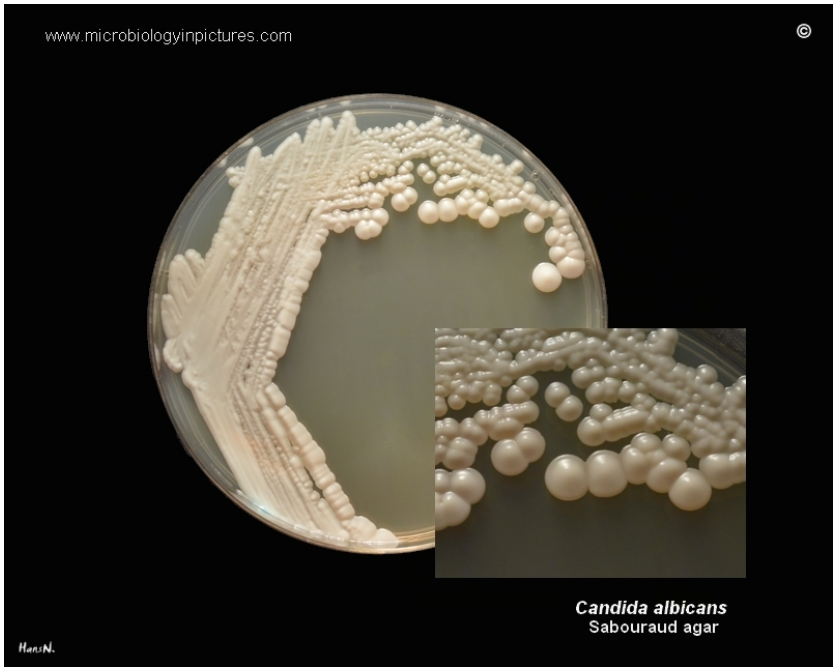
Morphology of Candida albicans



- 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)

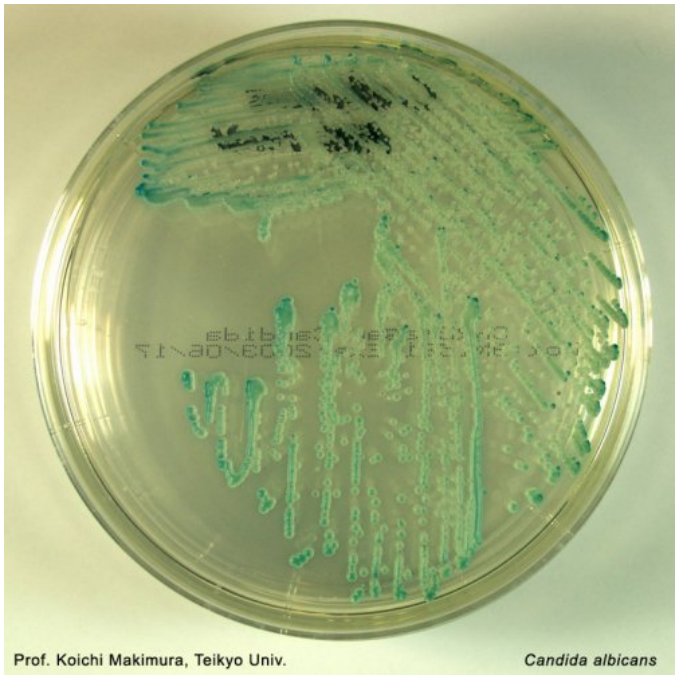
Blood Agar

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

PDA

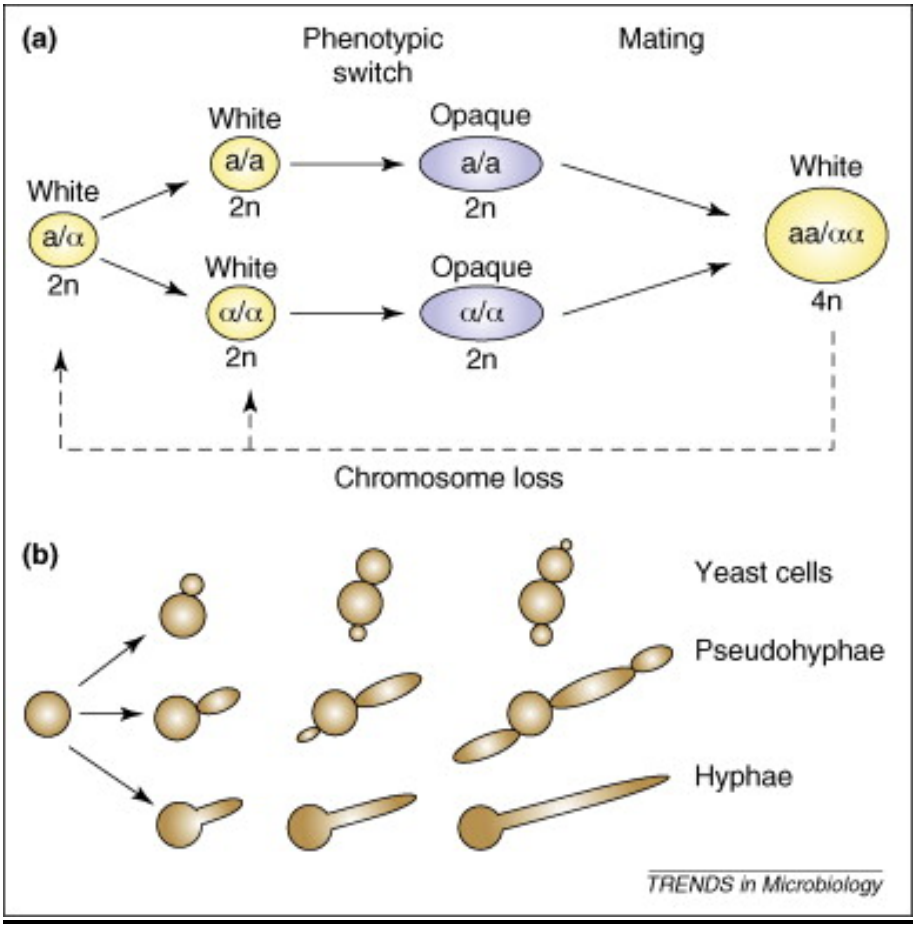
- Smooth creamy colonies after 24-48 hours

CHROMAGAR



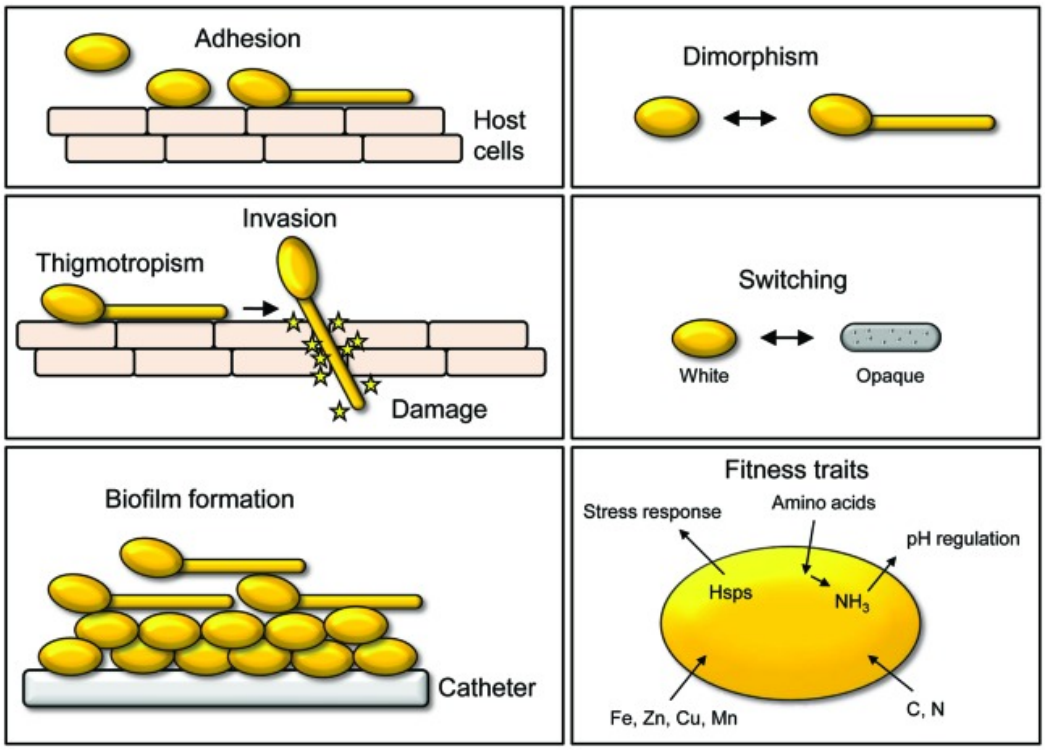
- Green colonies

Life Cycle of Candida albicans



- 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

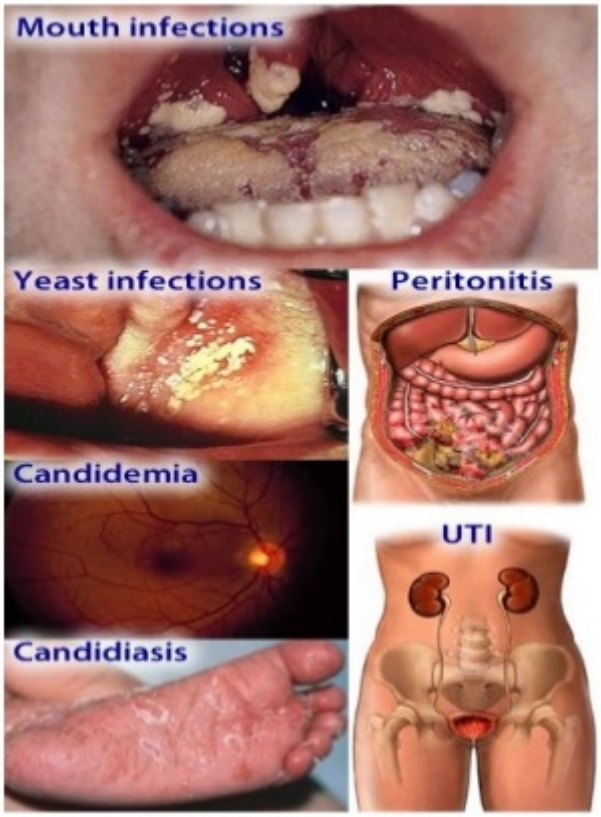
2. **Superficial Infection**
- Epithelial penetration
- Degradation of host protein

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



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 borne 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.
4. **Vulvovaginitis:** single dose of oral fluconazole, topical antifungals (butoconazole, clotrimazole, miconazole, nystatin, ticonazole, terconazole).
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