

1. Morphological Classification

- ① **Yeast** eg: *Cryptococcus sp*
- ② **Yeastlike** & pseudohypha : eg: *Candida sp*
- ③ **Moulds** (mycelia, spores) eg: Dermatophytes
- ④ **Dimorphic fungi**:- [37°C / Host tissues → Yeast phase.
[R.T. / cultures → Mycelium.
eg: Most medically important fungi.

2. Systematic Classification: (Based on Sexual spores)

- ① **Phycomycetes** {Sexual spores: Oospore / Zygosporangium}
{Asexual spores: Sporangiospore on sporangium}
eg: *Mucor*, *Rhizopus*, *Absidia*.
- ② **Ascomycetes** {sexual: Ascospore in ascus}
{Asexual: Conidia, arthrospores}
eg: yeasts, some filamentous fungi
- ③ **Basidiomycetes** {sexual: Basidiospore on basidium
Asexual: Arthrospores (!)}
eg: *Basidiobolus sp*.
- ④ **Fungi imperfecti (Deuteromycetes)**: Spore phase
 - Sexual spore phase not yet known.
eg: Most medically important fungi.

3. Mycoses:

- ① **Superficial**: 'dead layers of skin . "No allergy"
 - ① **Surface infections**: - Pityriasis sp.
 - Tinea nigra
 - Piedra - Black - *P. hortae*

- White – T. beigelii

⑥ **Cutaneous infections: -I. Dermatophytosis :**

Trichophyton

Microsporum

Epidermophyton

2.Candidiasis.

② **Deep**

① **Subcutaneous:** (*Mnem: my cro special remedial program*)

- Mycetoma
- Chromoblastomycosis
- Sporothrix
- Rhinosporidium
- Subcutaneous phycomycosis

② **Systemic** (*Mnem: CBC platelet histo*)

- Cryptococcosis
- Blastomycosis
- Coccidioidomycosis
- paracoccidioidomycosis
- Histoplasmosis

③ **Opportunistic:** (in debilitated, immunocompromised)

eg. Aspergillus, penicillium, Mucor, Rhizopus.

Lab Diagnosis: "Exercise in contemplative Observation"

1. Microscopy:

Specimens: - Skin scrapings, Nail clippings, hair
Colonies (from culture) -
Tissue specimens / Blood –

Process: - Skin / nail / hair → KOH 10% → Lactophenol Cotton Blue (LPCB)
Colonies → Tease mount → LPCB

Tissue specimens / Blood → **Calcofluor staining** / Gram staining / PAS / Methanamine silver

2 . Culture:

Media: ① **Sabourauds Dextrose Agar (pH 5.4)** with or without Antibodies / Cycloheximide (Actidione)

② **Corn meal agar** : to dem: special structures

③ **Czapex Dox medium** : " "

Cultures done in - ① Tubes ② Plates ③ Slide culture

Incubation: - In parallel **at 37°C & 22°C (RT)**

Read: - may take weeks.

- ① **Obverse:** growth, colour, texture of colonies → Tease & observed under microsc. → morphology of hyphae, spores & special texture viz:
 - spiral hyphae
 - racquet hyphae
 - favic chandelier
- ② **Reverse:** Pigmentation.

Smear: Hyphae - **Aerial & Vegetative**

Asexual Spores: - Blastospores (Budding)

Arthrospores & Conidia → Microconidia / Macroconidia)

Chlamydospores

I. Superficial Mycoses: -

① Surface infections:

- ① **Pityriasis versicolor (or Tinea versicolor)** – Stratum corneum
 - discrete or confluent macular areas of discolouration
 - Chest, abdomen, Upper limb, back.
 - *Pityrosporum orbiculare (Malassezia furfur)*

- Lipophilic.
 - → SDA c̄ over lay of olive oil, yeast + branched filaments.
- ② **Tinea Nigra.** – on stratum corneum of palms
 - Black-brown macular lesions. Tropics
 - *Cladosporium werneckii*
 - Skin scraping : Budding cells & branched septate hyphae.
 - SDA : grey-black colonies.
 - ③ **Piedra:** – hair – firm irregular nodules on shaft
 - - Black piedra - *Piedraia hortae* -
 - - white piedra - *Trichosporon beigeli*

I. Superficial Mycoses contd.....

② Cutaneous infections : Dermatophytosis & Candida.

① Dermatophytoses: –(Tinea, Ringworm).

- Superficial keratinised tissue skin, hair, nail.
- Metabolites percolate → Allergic Rns

- eg **Dermatophytid (ID) Reactions.**

Genera : Based on Macroconidia : **Trichophyton**

Microsporum

Epidermophyton

- **Morphology** : in lesions → hyphae & arthrospores
- On SDA → hyphae & Macroconidia & Microconidia
- **Sexual stage** : Some species 'sexual' stages has been identified .
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- Grow only on Keratinised layer of skin. But metabolites percolate in allergic reactions – even in different areas

Dermatophytid (ID) Reactions.

- → Demo. c̄ "Trichophytin" Skin test
- **Ⓐ Trichophyton**: → Skin, Hair, Nails . Resistant to Rx
 - SDA → powdery, velvety, waxy + pigment.
 - **LPCB** → Microconidia +++ . Macroconidia → few.
 - Special hyphal structures (spiral, raquet, favicchandelier)
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- **Ⓑ Microsporum** → Hair, Skin.
 - **SDA**: Cottonlike, velvety /powdery colonies – brown pigment

- Few Microconidia : Macroconidia, large spindle shape
- Multicellular borne singly on hyphae.
- **© *Epidermophyton*** – Nail, Skin.
 - **SDA** → powdery, greenish yellow.
 - NO microconidia. Macroconidia is club shaped, multicellular
 - in clusters. (Pear)

Classification based on site of infection :

- ① ***Tinea capitis*** – *Microsporum sp.* , *Trichophyton sp*
- ② **Favus:** – *T. schoenleinii*, *T. violaceum*, *T. gypseum*
- ③ ***Tinea barbae*** → *T. rubrum*, *T. mentagrophytes*, *T. verrucosum*
- ④ ***Tinea imbricata*** → *T. concentricum*.
- ⑤ ***Tinea corporis***. – *T. rubrum*, ... anyoth
- ⑥ ***Tinea cruris*** – *E. floccosum*, *T. rubrum*
- ⑦ ***Tinea pedis*** – *T. rubrum*, *E. floccosum*.
- ⑧ **Ectothrix** – *Microsporum sp.*, *T. rubrum*, *T. mentagrophytes*
- ⑨ **Endothrix** : *T. schoenleinii*, *T. tonsurans*, *T. violaceum* ---

Epidemiology: W.W. ← c̄ cultural / social habits. Hormones, age

Classification based on Natural habit.

- **Anthropophilic** – Mild, chronic, Resistant to Rx
 - *T. rubrum*}, *E. floccosum*, *M. audouinii*
- **Zoophilic** – *T. verrucosum*, *M. canis*
 - Severe inflammation, easy cure.
- **Geophilic** – less pathogenic –
 - *M. gypseum*, *T. ajelloi*

'Woods lamp: (uv lamp to detect areas of infection on scalp)

Rx - Topical antifungal
Grisofolvin orally

②. Candidiasis: (moniliasis) → skin, mucosa, visceral.

→ Ovoid / spherical, budding cells & pseudomycelium in culture.

→ Normal flora: skin & mucosa. → opportunistic infection. & Tissue. PM

① Cutaneous – Intertriginous Sharply demarcated { @ erythematous
scaly

or moist lesions & Paronychia , Onychial lesions

Groin Perineum, axilla inframammary fold & **washer womans hand**

• **② Mucosal** -

◦ **Vaginitis.** – acidic discharge. esp. pregnancy

Oral thrush – 'Bottle fed', aged. → creamy white patches on tongue / oral cavity, bleeds when removed

◦ **Visceral: Intestinal** → diarrhoea - antibiotics

◦ **Bronchopulmonary** – aft: pulmonary / systemic infect.

Septicemia

Endocarditis

Meningitis

→ Terminal complications? in Severe generalised disease - eg. Leukemia or prolonged immunosuppre.

Candida granuloma

Chronic mucocutaneous candidiasis

Lab diagnosis

Microscopy: wet film, LPCB, Gram stain → budding (gm +ve) cells
→ Dem. of mycelial form

Culture: - SDA & BA → white/ creamy, smooth, emulsifiable

- **DD. Candida albicans** → Growth on BA}
- → Chlamydospores on CMA (RT)
- → Reynold – Braude
- Germ tube test(+ Serum, 37°C X 2 hrs)

Other Candida species:

- *Candida albicans*:
- *C. Stellatoidea*
- *C. Tropicalis*
- *C. pseudotropicalis*
- *C. krusei*
- *C. guilliermondii*
- *C. Parapsilosis*
- *C. viswanathii*

Skin test: ubiquitous commensal. So (DH) → test of CMI

Rx - predisposing cause

Nystatin.

Amphotericin B

5-Fluorocytosine

Clotrimazole

- for disseminated candidiasis

Deep Mycosis

Deep Mycosis: - **Subcutaneous**

-**Systemic**

1. Subcutaneous mycosis: (*My Cro Sp. Remedial program*)

1. Mycotic mycetoma
2. Chromoblastomycosis
3. Sporotrichosis
4. Rhinosporidiosis
5. Subcutaneous phycomycosis

① Mycotic mycetoma:

chronic slowly progressive, inf. of SE Asia + Tropics.

Gill. 1842. Carter (1860) – Madura mycosis.

Padavalmika – Atharva Veda.

Cause: Actinomycetes & filamentous fungi:

- **White-yellow granules:**

- *Nocardia asteroides*
- *Nocardia brasiliensis*
- *Actinomadura madurae*
- *Streptomyces somaliensis*
- *Allescheria boydii*
- **Brown Black:**
 - *Madurella mycetomi*
 - *Madurella grisea*
 - *Phialophora jeanselmei*

DD: Botryomycosis ← staphylococcus etc.

- in Actinomycotic lesions: → grains → thin ($< 1 \mu\text{m}$) & Sulfonamides
- in mycotic lesions → grains → broad filaments & septate + Chlamydospores

Pathogenesis:

Enter small trauma → small swelling → burrows deep → multiple sinus discharging viscid seropurulent fluid + granules (mycelium)

Colour of granules

White – Yellow	Brown - Black	Red
• <i>Nocardia asteroides</i>		
• <i>Nocardia brasiliensis</i>	• <i>Madurella mycetomi</i>	
• <i>Actinomadura madurae</i>	• <i>Madurella grisea</i>	<i>Actinomadura pelletieri</i>
• <i>Streptomyces somaliensis</i>	• <i>Phialophora jeanselmei</i>	
• <i>Allescheria boydii</i>		

④ Chromomycosis - Dematiaceous fungi

- **① Chromoblastomycosis:** Verrucous dermatitis.
 - Dis: → mainly cauliflower like nodules on foot, S.C.
 - * **Fonsecaea**: *F. pedrosoi*, *F. compacta*, *F. dermatitidis*. (Exophiala)
 - * **Phialophora**: *P. verrucosa*
 - * **Cladosporium**: *C. carrionii*
 - **In tissue: Copper pennies** → (**Sclerotic bodies**) brown single Yeast-like in KOH prep & H&E sections
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- **Other Dematiaceous fungi - (Phaeohyphomycosis)**
 - Localised or systemic. (S.C, deep tissue, Brain)
 - - *Phialophora*,
 - *Cladosporium* etc. → Brown filaments
 - No sclerotic bodies. distorted hyphae etc.

⑥ Sporotrichosis - *Sporothrix schenckii*.

- W.W. (S.A)
- **Infection** → skin, S.C, LN → Nodules → break down → ulcers →
- **Rose gardeners disease**
- Plants / thorns → implantation (Usually hands)
- **Micro:** cigar shaped yeast cells (c̄ / surrounded by eosinophilic asteroid material around)
- **Culture report:** - Dimorphic fungus.
- Yeast 37°C. Mycelial form* @ room temp
 - *long & thin septate hyphae c̄ flower like clusters of conidia on delicate sterigmata.

④ Rhinosporidiosis - *Rhinosporidium seeberi*

- India, Srilanka. → nose, mouth, eye (mucous membrane. → friable polyp / mass)
- * **Histo** - Many fungal spherules embedded in stroma c̄ thousands of endospores
- From stagnant water?
- Not been cultured.

⑤ Subcutaneous phycomycosis - painless SC nodule →

enlarge & involve entire limb.

- *Basidiobolus haptosporus* - decaying vegetal, reptile
- ? mycetoma. / abscess.

.Systemic Mycoses. (Mnem : C.B.C, Platelet, Histo)

① Cryptococcosis

② Blastomycosis – Chromoblastomycosis & other dematiaceous fungal infections

③ Coccidioidomycosis

④ Paracoccidioidomycosis.

⑤ Histoplasmosis.

Cryptococcosis: ('European blastomycosis') (Torulosis)

- **True yeast:** The only pathogenic species: *Cryptococcus neoformans*
- Belongs to Basidiomycetes.
- **2 sexual stages:** *Filobasidiella neoformans*,
• *Filobasidium bacilliformis*
- **Asexual** → Round/ovoid budding yeast cells. 9–20µm with
• **Polysaccharide capsule.**
- **Habitat:** Soil, **Pigeon feces** → **Mode of infection:** Inhalation
- **Disease:** The **only deep mycosis in India?**
- **Infections:** - mostly asymptomatic.

① **Pulmonary Cryptococcosis** → Mild pneumonia. No calcification (xray negative)

② **Dissemination Visceral** (Bone, Joint),

Cutaneous - Granulomas, ulcers
• **Meningitis** insidious, slowly progressive
• esp in AIDS etc.

Lab. Diagnosis:

① **Microscopy:** Capsulated budding yeast cells ← **India Ink preparation**

② **Culture:** on SDA → Smooth, mucoid, Creamy colonies

D/D from other Cryptococcus spp:

1 .grow at 37°C

2 .Hydrolyse Urea

3.I.C. injection→mice→Capsulated budding yeasts in its brain.

Capsular polysaccharide (ABCD)dem. By PPT test

P.S. It can cause Mastitis in cattle → ? connection c̄ Human disease

Treatment: Amphotericin B, 5-fluorocytosine, Clotrimazole.

② **Blastomycosis** – (North American)

- Blastomyces dermatitidis.
- Soil → Suppurative & granulomatous lesions → Lung & skin.
- ① Pulmonary – like TB
- ② Cutaneous. – Skin of face → papule, secondary papule converge → ulcer.
 - **In tissue** = 37deg C - Budding yeast cell – double wall – one broad based bud
 - **R.T. cult.** –filamentous, septate, with oval conidia. + chlamydospores

③ **Paracoccidioidomycosis** → (South America.)

→Skin, mucosa, LN & internal organs.

- Granuloma & ulcer / Buccal & nasal mucosa.
- *Paracoccidioides brasiliensis*
 - Yeast phase in Tissue- Large round cell with multiple buds
→ mycelium

④ *Coccidioidomycosis*. S.W. USA

→ *Coccidioides immitis* – benign → fatal.

Sources : Soil / rodents → inhalation of arthrospores → asymptomatic → **Valley fever (Desert Rheumatism)**

Skin Test = Coccidioidin.

→ 10% – Disseminated → coccidioidal granuloma → fatal.

- In tissue yeast - Spherule with endospores
- culture - both 37° & RT → mycelial. arthrospores

SS: DD TB

⑤ *Histoplasmosis*: 'darlings diseases' (1905)

1. - *H. capsulatum*

- **Dimorphic fungus:** → Intracellular inf: of RE system
- w.w. – USA. soil & Rotting trees, bird feces → Inhalation
- **Disease:** asymptomatic → with miliary calcification → pulmonary disease → DD TB → Disseminated histoplasmosis → RE system → LN ++, Hepatosplenomegaly, Fever, anaemia → Death.
- Granulomatous ulcers of skin
- **In tissues: inside phagocytes.** yeast phase oval budding 2-4µ.

Diagnosis

- ① Smear of Blood, BM, scrapings of ulcers, biopsy of LN.
- ② culture: SDA white cottony mycelia – 8-20µ thick walled spore c̄ tubercles . Also **grows on BA @ 37**
- ③ Ab – Latex aggl., CFT, PPT. // DH – histoplasmin.

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• 2. *H. duboisii*

African Histoplasmosis – skin & SC & bone. *H. duboisii* large yeast mycelial form same.

Rx Amphotericin B, higher dose/ duration)

③ Opportunistic Infection: - Debilitated Pts

① *Aspergillus*

② *Penicillium*

③ *Mucormycosis*. *

* *Aspergillus*: 300+ species. - *Asp. fumigatus*, pathogenic to birds and humans. - commonly cause: **Otomycosis**.

- **Systemic aspergillosis** - ① **Aspergillus Asthma** - atopic/allgy -

② **Bronchopulmonary Aspergillus** → bronchiolitis → invasive

③ **Colonising aspergillus** → pre existing cavities. "**cannon balls**"

④ **Disseminated Aspergillus**. - → organs: Brain, Kidney, etc. -

– Dg: - **Microscopy**

Culture - Rapid growth.

- asexual conidia in chains on vesicles of conidiophores.

• ***Penicillium***: - *P. marneffei* - HIV (Fatal)

- brushlike arrangement of conidia

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• * ***Mucormycosis*** - *Rhizopus*, *Mucor*, *Absidia*

- **Primary infection** → URT / nose → spores generate → palate, adjacent tissue → orbit, sinuses, brain also lung.

- → invade artery → thrombosis & infarction - Fatal.

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- **In tissue:** Broad, nonseptate mycelium in tissue.

- **culture** on SDA without Cycloheximide.

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- ***Mucor*** - branched sporangiophores arising randomly along mycelium. No rhizoid

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- ***Rhizopus*** - Rhizoids + & sporangiophores arise in groups directly above them

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• **④ OTOMYCOSIS** · · *Asp. niger*, *Asp. fumigatus*. Dg - Fungi in serum Myros / cult. → Secondary bact. infect. - *Pseudomonas*, *Proteus* → Suppuration..

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- **5. OCULOMYCOSIS** keratomycosis
 - Trauma → fungal spore → inflammat → hypopyon endophthalmitis
 - Deep scrapings required
 - eg. *Aspergillus*, *Fusarium*, *candida albicans*.
 - Rx.** Amphotericin B, Nystatin, Pimaricin, Natamycin