**Difference between bacterial spore and fungal spore:**

| Bacterial spore | Fungal spore |
|---|---|
| 1. They are produced in adverse environmental condition as a protective mechanism. | 1. They are produced for reproduction. |
| 2. The spores are resistant to heat and chemicals. | 2. They are not resistant to heat and chemicals. |
| 3. They are usually endospores. | 3. They are exospores. |
| 4. Exosporium, spore coat and spore cortex are present. | 4. No exosporium, spore coat and spore cortex. |

**Zygomycota:** Zygote forming fungi
**Ascomycota:** Sac fungi
**Basidiomycota:** Club fungi
**Deuteromycota:** Imperfect fungi

**Important:**

- Tinea is dermatophytic infection.
- Taenia is a helminth.

**Q. What are the causative agents of tinea capitis or onychomycosis?**

**Causative agents of tinea capitis or onychomycosis:**

1. Trichophyton
2. Epideromophyton
3. Microsporum

**Tinea pedis (Athlete's foot)**

This is a chronic dermatophytic infection of the toe webs. Tinea pedis is the most prevalent of all dermatophytes.

**Site of infection:** Foot (in between toes). From this site it may extend to involve the nails.

**Agent:**

1. *Trichophyton rubrum*
2. *T. mentagrophytes*
3. *Epidermophyton floccosum*

**Clinical features:**

1. Initially, itching between the toes and small vesicles that rupture and discharge a thin fluid.
2. Cracks appear in the skin of the toe webs, where secondary bacterial infection occurs.
3. When the fungal infection becomes chronic, peeling and cracking of the skin are the principal manifestations, accompanied by pain and pruritis.
4. Other varieties are the vesicular, ulcerative and moccasin type, with hyperkeratosis of the sole.



**Laboratory diagnosis of dermatophyte infections:**

**Principle:** Diagnosis is based on the demonstration of fugal structure on the specimen by microscopic examination, and isolation and identification of fungus from culture.

**Steps:**

A. **Specimen collection:**
   1. Skin scrapping
   2. Nail clipping
   3. Hair plucking

B. **Microscopic examination:** The specimen is dissolved in KOH solution.
   - **Skin:** 10% KOH for at least 1 hour.
   - **Nail:** 40% KOH for at least 10 hours.
   - **Hair:** 20% KOH for at least 10 hours.

   **Findings:**

   - **Skin and nail:** Septate hyphae with arthrospores.
   - **Hair:** Ectothrix (fungal spores outside the hair shaft) and endothrix (fungal spores inside the hair shaft).

C. **Isolation and identification from culture:** Specimen is incubated in Sabouraud's dextrose agar at 25 – $30^0$ C for 3 – 4 weeks.

   **Findings:** Dermatophytes are identified by their colonial appearance and microscopic morphology.

# *Histoplasma capsulatum*

*Histoplasma capsulatum* is a systemic fungus that causes histoplasmosis.

**Properties:**

1. It is dimorphic fungus that exists as a mold in soil and as a yeast in tissue.
2. It forms two types of asexual spores:
    - Tuberculate Macroconidia with typical thick walls and fingerlike projections that are important in laboratory identification.
    - Microconidia which are smaller, thin, smooth-walled spores that if inhaled, transmit the infection.
3. Multiply within the mononuclear cells or endothelial cells.
4. Produce budding yeast.

**Transmission:** Infection result from inhalation of the spores of dimorphic fungi.

**Epidemiology:** It grows in soil, particularly if the soil is heavily contaminated with bird droppings, especially from starlings.

**Pathogenicity/ Clinical manifestation/ Clinical features:**

1. **Chronic pulmonary histoplasmosis:** It is characterized by severe coughing, blood-tinged sputum, night sweats, loss of appetite and weight loss. It is often seen in individuals with preexisting lung disease. It can be mistaken for tuberculosis.
2. **Chronic cutaneous histoplasmosis:** It is characterized by ulcerative skin lesion, can follow the spread of infection from the lungs.
3. **Systemic histoplasmosis:** It can follow if infection spreads from the lungs, but it is usually seen only in AIDS patients. This syndrome, characterized by enlargement of the spleen and liver, can be rapid, severe and fatal.
4. **Ocular histoplasmosis:** It is a type 4 hypersensitivity reaction against Histoplasma in the eye. It is characterized by inflammation and redness.



**Pathogenesis:**

Inhaled spores enter to the lungs
↓
Engulfed by macrophages
↓
Develop into yeast form in the lung
↓
Budding of yeast inside macrophages
↓
Yeasts survive within the macrophages by producing alkaline substances e.g. $HCO_3^-$, $NH_3$.
↓
With macrophages, yeasts disseminate to reticuloendothelial tissues such as liver, spleen, bone marrow and lymph nodes.
↓
Formation of granuloma in different organs
↓
Most infections remain asymptomatic and small granulomatous foci heal by calcification.
↓
Intense exposure (e.g. in chicken house or bat-infested cave) results in pneumonia
↓
Severe disseminated histoplasmosis develops in immunocompromised patients e.g. AIDS patients.

### *Aspergillus*

**Properties:**

1. Aspergillus species exist only as molds; they are not dimorphic.
2. They have separate hyphae that form V shaped branches.
3. The walls are more or less parallel.
4. The conidia of Aspergillus form radiating chains.

**Diseases caused by Aspergillus:**

1. Infection of skin, eyes, ears and other organs.
2. Fugal ball in the lungs.
3. Allergic broncho-pulmonary aspergillosis.

**Transmission:** Transmission is by airborne conidia.

4. Asexual spore formation

## Nystatin

Nystatin is an antifungal agent used to Candida infections of the skin including diaper rash, thrush, esophageal candidiasis and vaginal yeast infections. It may also be used to prevent candidiasis in those who are at high risk.

**Mechanism of action:**

Nystatin binds to ergosterol
↓
Forms pores in the membrane
↓
This leads to $K^+$ leakage, acidification and death of the fungus.

**Medical uses:**

1. Oral nystatin is often used as a preventive treatment in people who are at risk of fungal infections, such as AIDS patients with a low CD4+ count and people receiving chemotherapy.
2. After liver transplantation.
3. Very low birth weight infants to prevent invasive fungal infections.
4. Systemic infections that are difficult to treat such as invasive aspergillosis or infections that demonstrate resistance to amphotericin B.

**Adverse effects:**

1. Hypersensitivity reactions, including Stevens – Johnson syndrome in some cases.
2. Rash, itching and burning.
3. Diarrhea
4. Abdominal pain



## Conidia

Conidia are asexual, non-motile spores of fungus.

**Other names:**

- Asexual chlamydospores
- Chlamydoconidia
- Mitospores

**Characteristics:**

1. They are non-motile.
2. They are generated through the cellular process of mitosis.
3. Asexual reproduction in Ascomycetes is by formation of conidia, which are borne on specialized stalks called conidiophores.
4. The morphology of specialized conidiophores is often distinctive of a specific species and can therefore be used in identification of the species.

## Yeast like fungi

Yeast like fungi are those that exist as a yeast for part of their life cycle, but can be hyphal for a significant portion of it. **Example:** *Candida albicans*.

**Method of reproduction:** Budding.

**Process:**

The cell wall bulge out and softens in the area probably by certain enzymes brought by vesicles

1. Dermatophytes
2. Candida species

**Risk factors:**

1. Aging is the most common risk factor for onychomycosis due to diminished blood circulation, longer exposure to fungi and nails, which grow more slowly and thicken, increasing susceptibility to infection.
2. Heavily perspiration.
3. Psoriasis
4. Athlete's foot
5. Minor skin or nail injury

**Diagnosis:** Diagnosis is generally suspected based on the appearance and confirmed by laboratory testing. The four main tests are –

1. Potassium hydroxide smear
2. Culture
3. Histology examination
4. PCR

**Medications:**

1. Topical antibiotics e.g. ciclopirox
2. Itraconazole and fluconazole may be taken orally.

## Ergot alkaloids

The ergot alkaloids are mycotoxins produced by several species of fungi in the genus of Claviceps. The name ergot means spur in French, since grains colonized with Claviceps species. Ergot poising in humans and domestic animals in known as ergotism.

**Classification:** There are four main groups of argot alkaloids:

1. Clavines
2. Lysergic acids
3. Lysergic acid amides and
4. Ergopeptides



**Producer:**

1. Ascomycota e.g. Claviceps
2. Penicillium
3. Aspergillus species

**Production:**

1. Chemical synthesis
2. Culture of Claviceps strains on the respective host.
3. Microbial fermentation
4. Surface culture
5. With immobilized cells

**Importance:**

1. Cause ergotism in humans and animals. It may cause –
    - Strange hallucinations
    - The feeling of itchy and burning skin
    - Gangrene
    - Loss of hands and feet
    - Death
2. Stimulation of the sympathetic nervous system.
3. Ergovanine is used to hasten labor and prevent postpartum bleeding.
4. Argotamine is a powerful vasoconstrictor i.e. it constricts blood vessels and thus the blood flow.