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## Fungal pathogenicity and diseases in human – A review

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### Abstract

The incidence of fungal infections is increasing at an alarming rate, presenting an enormous challenge to healthcare professionals. This increase is directly related to the growing population of immunocompromised individuals especially children resulting from changes in medical practice such as the use of intensive chemotherapy and immunosuppressive drugs. Fungi can occur in the form of yeast, mould, and dimorph. In children fungi can cause superficial infection, i.e., on skin, nails, and hair like oral thrush, candida diaper rash, tinea infections, etc., are various types of superficial fungal infections, subcutaneous fungal infection in tissues under the skin and lastly it causes systemic infection in deeper tissues. Most superficial and subcutaneous fungal infections are easily diagnosed and readily amenable to treatment. Opportunistic fungal infections are those that cause diseases exclusively in immunocompromised individuals, e.g., aspergillosis, zygomycosis, etc. Systemic infections can be life-threatening and are associated with high morbidity and mortality. Because diagnosis is difficult and the causative agent is often confirmed only at autopsy, the exact incidence of systemic infections is difficult to determine. The most frequently encountered pathogens are *Candida albicans* and *Aspergillus* spp. But other fungi such as non-albicans *Candida* spp. are increasingly important.

**Keywords:** Pathogenic fungi, opportunistic pathogens, virulence factors, fungal infections

### 1. Introduction

Mycology is the branch of biology concerned with the study of fungi, including their genetic and biochemical properties, their taxonomy and their use to humans as a source for tinder, medicine, food, and entheogens, as well as their dangers, such as poisoning or infection. A biologist specializing in mycology is called a mycologist. Many fungi produce toxins, antibiotics, and other secondary metabolites. Fungi are fundamental for life on earth in their roles as symbionts, e.g. in the form of mycorrhizae, insect symbionts, and lichens. Many fungi are able to break down complex organic biomolecules such as lignin, and pollutants such as xenobiotics, petroleum, and polycyclic aromatic hydrocarbons. By decomposing these molecules, fungi play a critical role in the global carbon cycle. Some fungi can cause disease in humans or other organisms. The study of pathogenic fungi is referred to as medical mycology [5].

A fungus (plural: fungi or funguses) is any member of the group of eukaryotic organisms that includes unicellular microorganisms such as yeasts and molds, as well as multicellular fungi that produce familiar fruiting forms known as mushrooms. These organisms are classified as a kingdom, Fungi, which is separate from the other eukaryotic life kingdoms of plants and animals. Fungi are ubiquitous in nature and exist as free-living saprobes that derive no obvious benefits from parasitizing humans or animals [3].

Pathogenic fungi are fungi that cause disease in humans or other organisms. The study of pathogenic fungi is referred to as "medical mycology." Although fungi are eukaryotic organisms, many pathogenic fungi are also microorganisms. There is also such a thing as veterinary mycology, but the types of diseases that are found in your pets often are the same as those that are found in people [2].

### Types of Fungal infections in humans

#### 1. Superficial Fungal Infections

Superficial fungal infections involve only the outermost layers of the stratum corneum of the skin or the cuticle of the hair shaft. These infections usually constitute cosmetic problems and rarely elicit an immune response from the host.

#### 2. Dermatophyte Infections

Species from the genera *Epidermophyton*, *Microsporum* and *Trichophyton* are most commonly involved. Species from the genera *Epidermophyton* species affect nails and skin, *Microsporum* species affect hair and skin while *Trichophyton* species affect hair, nails and

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### 3. Subcutaneous Mycoses

The fungi that have been implicated in the subcutaneous mycoses are abundant in the environment and have a low degree of infectivity. These organisms gain access to the subcutaneous tissues through traumatic implantation.

### 4. Systemic Mycoses

The fungi that have been implicated in human disease, only the six agents that cause the systemic mycoses have the innate ability to cause infection and disease in humans and other animals. The systemic agents are *Histoplasma capsulatum*, *Blastomyces dermatitidis*, *Paracoccidioides brasiliensis*, *Coccidioides immitis*, and *Penicillium marneffei* are. The primary site of infection is the respiratory tract.

#### Types of Pathogenic fungus diseases

- **Aspergillosis:** Caused by the fungus *Aspergillus* and usually occurs in people with lung diseases or weakened immune systems.
- **Candidiasis:** Caused by the yeast *Candida*. Candidiasis can occur in the mouth and throat, vagina, or the bloodstream.
- **Histoplasmosis:** Caused by the fungus *Histoplasma*, which lives in the environment, often in association with large amounts of bird or bat droppings.
- **Ringworm:** A common fungal skin infection that often looks like a circular rash.
- **Sporotrichosis:** Caused by the fungus *Sporothrix*, which lives throughout the world in soil and on plants,<sup>[2]</sup>

#### Pathogenicity and virulence

Depending on the virulence and pathogenicity there are broadly two types of fungi: true pathogenic fungi and opportunistic fungi. The ability of the fungi to grow at 37 °C and adapt to the environment inside the host tissues helps them to establish and cause infection. Factors responsible for fungal pathogenicity are specific to the fungus. Enzymes, toxins and by products of various fungi play an important role in their virulence and pathogenicity. *Aspergillus spp.* produces proteases and aspartic acid proteinase. Gliotoxin and restrictocin are the toxins produced by *Aspergillus spp.* *Candida spp.* is an opportunistic fungi, that being a normal flora of human can be responsible for significant infections from superficial skin and nail infections to urinary tract infections and candidemia<sup>[3]</sup>

#### Drug Resistance

The antifungal antibiotics target various stages of metabolic pathways and are placed in different groups including azoles, polyenes, fluoropyrimidine analogs, echinocandins, morpholines, allylamines and thiocarbamates. 5-Fluorocytosine (5-FC) and 5-Fluorouracil are the two antifungals derived synthetically from DNA nucleotide cytosine that are used to treat human infections. 5-FC possesses a broad spectrum of activity not only against fungi but also protozoa. 5-FC has been recommended against fungal infections always as a combination drug with other antifungal agent as fungi have ability to acquire resistance. Amphotericin-B nystatin and natamycin are only the three polyene/macrolide group of antifungal drugs used to treat human infections which are synthesized from Streptomyces bacteria<sup>[1, 4]</sup>

### Diagnosis of fungal infections

Diagnosis of fungal infections is problematical and many infections are confirmed only at autopsy. In addition, the isolation of fungi from clinical samples is unreliable and may be complicated by the presence of a colonizing commensal organism, or ubiquitous fungi in the environment, causing false-positive results. Serological tests that detect antibodies are low in sensitivity and specificity because many patients with systemic fungal infections are immunocompromised and, therefore, have an impaired antibody response. The diagnosis of aspergillosis include the greater use of routine high-resolution computed tomography (CT) scanning, PCR for the detection of RNA or DNA, and ELISA testing for circulating galactomannan, a component of the fungal cell wall in *Aspergillus*<sup>[3]</sup>.

### Conclusion

The Pathogenic fungal infections are increasing at an alarming rate. The HIV epidemic and other diseases of the immune system have added to this growing at-risk population. Superficial fungal infections are mild but may spread to other areas of the body or, occasionally, to other individuals. More seriously, but less frequently, they may develop into invasive forms. Systemic fungal infections in immunocompromised patients, such as bone marrow and solid organ transplant recipients, are associated with high rates of mortality. *C. albicans* and *Aspergillus spp.* are the most prevalent pathogens in systemic infections, in addition to rare infectious agents such as *M. furfur*. Although the incidence of fungal infections can be reduced by minimizing risk factors in hospitals, such as poor hygiene practice, our inability to reliably prevent such infections highlights the need for effective treatments.

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