

Lecture-1- Fungi (Mycosis)

They are a diverse group of saprophytic and parasitic eukaryotic organisms. Human fungal diseases (mycoses) are classified by the location on or in the body where the infection occurs. They are called **cutaneous** when limited to the epidermis, **subcutaneous** when the infection penetrates significantly beneath the skin, and **systemic** when the infection is deep within the body or disseminated to internal organs. **Systemic mycoses** can be further divided into those that are caused by **true pathogenic fungi** capable of infecting healthy individuals, and those that are **opportunistic**, infecting primarily those individuals who have predisposing conditions such as immunodeficiency or debilitating diseases. Fungi produce and secrete a variety of unusual metabolic products, some of which, when ingested, are highly toxic to animals, including humans. Thus, fungi can cause poisonings as well as infections. Lastly, fungal spores are important as human allergenic agents.

Characteristics of Major Fungal Groups

Fungi can be distinguished from other infectious organisms such as bacteria or viruses because they are eukaryotes (that is, they have a membrane-enclosed nucleus). Their characteristic structures, habitats, and modes of growth and reproduction are used to distinguish between different groups of fungi.

A. Cell wall and membrane components

The fungal cell wall and cell membrane are fundamentally different from those of bacteria and other eukaryotes. Fungal cell walls are composed largely of chitin, the fungal membrane contains ergosterol, rather than the cholesterol found in mammalian membranes.

B. Habitat and nutrition

All fungi are heterotrophs; that is, they require some preformed organic carbon source for growth. Fungi do not ingest food particles as do organisms such as protozoa, but depend upon transport of soluble nutrients across their cell membranes. To obtain these soluble nutrients, fungi secrete degradative enzymes (for example, cellulases, proteases, nucleases) into their immediate environment. It is this ability that enables fungi to live saprophytically

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on organic waste. Therefore, the natural habitat of almost all fungi is soil or water containing decaying organic matter. [Note: Some fungi can be parasitic on living organisms. However, these parasitic infections usually originate from the individual's contact with fungus-infested soil, an exception being *Candida*, which is part of the normal human mucosal flora

C. Modes of fungal growth

Most fungi exist in one of two basic morphologic forms (that is, either as filamentous mold or unicellular yeast). However, some fungi are dimorphic (that is, they switch between these two forms in response to environmental conditions).

Table 45-1. The major mycoses and causative fungi.

Type of Mycosis	Causative Fungal Agents	Mycosis
Superficial	<i>Malassezia</i> species <i>Hortaea werneckii</i> Trichosporon species <i>Piedraia hortae</i>	Pityriasis versicolor Tinea nigra White piedra Black piedra
Cutaneous	<i>Microsporum</i> species, trichophyton species, and <i>Epidermophyton floccosum</i> <i>Candida albicans</i> and other candida species	Dermatophytosis Candidiasis of skin, mucosa, or nails
Subcutaneous	<i>Sporothrix schenckii</i> <i>Phialophora verrucosa</i> , <i>Fonsecaea pedrosoi</i> , others <i>Pseudallescheria boydii</i> , <i>Madurella mycetomatis</i> , others Exophiala, bipolaris, exserohilum, and others	Sporotrichosis Chromoblastomycosis Mycetoma Phaeohyphomycosis
Endemic (primary, systemic) <i>of Deep</i>	<i>Coccidioides immitis</i> , <i>C posadasii</i> <i>Histoplasma capsulatum</i> <i>Blastomyces dermatitidis</i> <i>Paracoccidioides brasiliensis</i>	Coccidioidomycosis Histoplasmosis Blastomycosis Paracoccidioidomycosis
Opportunistic	<i>Candida albicans</i> and other candida species <i>Cryptococcus neoformans</i> <i>Aspergillus fumigatus</i> and other aspergillus species Species of rhizopus, absidia, mucor, and other zygomycetes <i>Penicillium marneffe</i>	Systemic candidiasis Cryptococcosis Aspergillosis Mucormycosis (zygomycosis) Penicilliosis

1-Filamentous (mold like) fungi: The vegetative body, or thallus, of mold-like fungi is typically a mass of threads with many branches. This mass is called a mycelium, which grows by branching and tip elongation. The threads (hyphae) are actually tubular cells that, in some fungi, are partitioned into segments (septate); whereas, in other fungi, the hyphae

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are uninterrupted by crosswalls (nonseptate). Even in septate fungi, however, the septae are perforated so that the cytoplasm of the hyphae is continuous. When hyphal filaments become densely packed, the mycelium may have the appearance of a cohesive tissue. An example of this is the body of a mushroom.

2-Yeast-like fungi: These fungi exist as populations of single, unconnected, spheroid cells, not unlike many bacteria, although they are some ten times larger than a typical bacterial cell. Yeast-like fungi generally reproduce by budding.

Some fungal species, especially those that cause systemic mycoses, are dimorphic, being usually yeast-like in one environment and mold-like in another. Examples of conditions that affect the choice of morphology are temperature and carbon dioxide levels.

D. Sporulation

Sporulation is the principal means by which fungi reproduce and spread through the environment. Fungal spores are metabolically dormant, protected cells, released by the mycelium in enormous numbers. They can be borne by air or water to new sites, where they germinate and establish colonies. Spores can be generated either asexually or sexually

Asexual sporulation: Asexual spores (conidia) are formed by mitosis in or on specialized hyphae (conidiophores,). The color of a typical fungal colony seen on bread, fruit, or culture plate is caused by the conidia; conidia can become airborne and, therefore, are a major source of fungal infection.

Sexual sporulation: This process is initiated when a haploid nucleus from each of two compatible strains of the same species fuse to form a transient diploid. The products of meiosis of this transient diploid become sexual spores (ascospores). Spores, especially sexual spores, often have a characteristic shape and surface ornamentation pattern that may serve as the primary or only means of species identification.

E. Laboratory identification

Most fungi can be propagated on any nutrient agar surface. The standard medium is Sabouraud dextrose agar, which, because of its low pH (5.0), inhibits bacterial growth

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while allowing fungal colonies to form. Various antibacterial antibiotics can also be added to the medium to further inhibit bacterial colony formation. Cultures can be started from spores or hyphal fragments. Clinical samples may be pus, blood, spinal fluid, sputum, tissue biopsies, or skin scrapings. Identification is usually based on the microscopic morphology of conidial structures. Serologic tests and immunofluorescent techniques are also useful in identification of fungi from clinical isolates.

Cutaneous Mycoses

Also called dermatophytoses, these common diseases are caused by a group of related fungi, the dermatophytes. Dermatophytes fall into three genera, each with many species: *Trichophyton*, *Epidermophyton*, and *Microsporum*.

Epidemiology

The causative organisms of the dermatophytoses are often distinguished according to their natural habitats: anthropophilic (residing on human skin), zoophilic (residing on the skin of domestic and farm animals), or geophilic (residing in the soil). Most human infections are by anthropophilic and zoophilic organisms. Transmission from human to human or animal to human is by infected skin scales.

Pathology

A defining characteristic of the dermatophytes is the ability to use keratin as a source of nutrition. This ability allows them to infect keratinized tissues and structures, such as skin, hair, and nails. There is some specificity, however. Whereas all three genera attack the skin, *Microsporum* does not infect nails and *Epidermophyton* does not infect hair. None invade underlying, nonkeratinized tissue.

Clinical significance

Dermatophytoses are characterized by itching, scaling skin patches that can become inflamed and weeping. Specific diseases are usually identified according to affected tissue (for example, scalp, pubic area, or feet), but a given disease can be caused by any one of several organisms, and some organisms can cause more than one disease depending, for example, on the site of infection or condition of the skin. The following are the most commonly encountered dermatophytoses.

A. Tinea pedis (athlete's foot): Organisms most often isolated from infected tissue are *Trichophyton rubrum*, *Trichophyton mentagrophytes*, and *Epidermophyton floccosum*. The infected tissue is initially between the toes, but can spread to the nails, which become yellow and brittle. Skin fissures can lead to secondary bacterial infections, with consequent lymph node inflammation.

B. Tinea corporis (ringworm): Organisms most often isolated are *E. floccosum* and several species of *Trichophyton* and *Microsporum*. Lesions appear as advancing annular rings with scaly centers. The periphery of the ring, which is the site of active fungal growth, is usually inflamed and vesiculated. Although any site on the body can be affected, lesions most often occur on nonhairy areas of the trunk.

C. Tinea capitis (scalp ringworm): Several species of *Trichophyton* and *Microsporum* have been isolated from scalp ringworm lesions, the predominant infecting species depending on the geographic location of the patient. In the United States, for example, the predominant infecting species is *Trichophyton tonsurans*. Disease manifestations range from small, scaling patches, to involvement of the entire scalp with extensive hair loss. The hair shafts can become invaded by *Microsporum* hyphae, as manifested by their green fluorescence in long-wave ultraviolet light (Wood lamp).

D. Tinea cruris (jock itch): Causative organisms are *E. floccosum* and *T. rubrum*. Disease manifestations are similar to ringworm, except that lesions occur in the moist groin area, where they can spread from the upper thighs to the genitals.

E. Tinea unguium (onychomycosis): The causative organism is most often *T. rubrum*. The nails are thickened, discolored, and brittle. Treatment must be continued for three to four months until all infected portions of the nail grow out and are trimmed off.

F. Tinea Barbae: The causative organism is most often *Trichophyton hair barbae*.

Treatment

Removal of infected skin, followed by topical application of antifungal antibiotics such as miconazole or clotrimazole, is the first course of treatment. Refractory infections usually respond well to oral griseofulvin and itraconazole. Infections of the hair and nails usually require systemic (oral) therapy. Terbinafine is the drug of choice for onychomycosis.

Table 45–2. Some clinical features of dermatophyte infection.

Skin Disease	Location of Lesions	Clinical Features	Fungi Most Frequently Responsible
Tinea corporis (ringworm)	Nonhairy, smooth skin.	Circular patches with advancing red, vesiculated border and central scaling. Pruritic.	<i>T rubrum</i> , <i>E floccosum</i>
Tinea pedis ¹ (athlete's foot)	Interdigital spaces on feet of persons wearing shoes.	Acute: itching, red vesicular. Chronic: itching, scaling, fissures.	<i>T rubrum</i> , <i>T mentagrophytes</i> , <i>E floccosum</i>
Tinea cruris (jock itch)	Groin.	Erythematous scaling lesion in intertriginous area. Pruritic.	<i>T rubrum</i> , <i>T mentagrophytes</i> , <i>E floccosum</i>
Tinea capitis	Scalp hair. Endothrix: fungus inside hair shaft. Ectothrix: fungus on surface of hair.	Circular bald patches with short hair stubs or broken hair within hair follicles. Kerion rare. Microsporum-infected hairs fluoresce.	<i>T mentagrophytes</i> , <i>M canis</i>
Tinea barbae	Beard hair.	Edematous, erythematous lesion.	<i>T mentagrophytes</i>
Tinea unguium (onychomycosis)	Nail.	Nails thickened or crumbling distally; discolored; lusterless. Usually associated with tinea pedis.	<i>T rubrum</i> , <i>T mentagrophytes</i> , <i>E floccosum</i>
Dermatophytid (id reaction)	Usually sides and flexor aspects of fingers. Palm. Any site on body.	Pruritic vesicular to bullous lesions. Most commonly associated with tinea pedis.	No fungi present in lesion. May become secondarily infected with bacteria.

