Introduction

Medical mycology deals with the nature and the causes of the diseases occasioned directly (mycoses and allergies) or indirectly (poisoning) by fungi. Mycotoxins are toxic molecules that are present in various moulds. Reference is made to mycetism when a mycotoxin causes poisoning directly, as is the case for instance with *Amanita phalloides* (Death Cap). Mycotoxicoses are diseases caused by ingestion of foodstuffs in which toxins are released and therefore involves an indirect form of poisoning. The most well-known example is aflatoxicosis caused by aflatoxins produced by *Aspergillus flavus*. Some moulds can cause allergic syndromes such as extrinsic allergic alveolitis (e.g. cheese washer's lung, maltworker's lung). All these conditions differ from mycoses, which are a parasitic type of infection. This text deals only with mycoses.

Beware of the term "mycotic" and "mycosis", which can be misleading, as in "mycotic aneurysms" (in general due to bacteria, e.g. in endocarditis), mycosis fungoides (a neoplastic disease), and bothryomycosis (*Staphylococcus aureus* infection).

The majority of medical important fungi are land organisms in contrast to some more primitive fungi which have more in common with protista and exhibit a motile stage.

Fungi are eukaryotes. They differ fundamentally in terms of cell structure and organisation from bacteria (prokaryotes) and are not susceptible to most antibacterial antibiotics. They are heterotrophic, in other words they have to obtain their energy from already existing organic molecules. Consequently, many fungi live in association with living plants (often as harmful parasites, but also as beneficial symbionts, cfr mycorhiza) or as free saprophytes on dead organic substances. Like bacteria, they feed by absorption.

Two groups are distinguished among the microscopic fungi:

- **yeasts**, unicellular organisms that proliferate by budding and identification of which is based predominantly on morphological, as well as biochemical, properties such as oxidative assimilation or fermentation of various sugars.
- **moulds**, which are identified on the basis of morphological characteristics (filamentous).

An important term to understand is: Dimorphic fungi. These are fungi that can exist in the form of both mould and yeast. This is usually brought about by change in temperature. An example is *Talaromyces marneffei*, a human pathogen that grows as a mold at room temperature and as a yeast at human body temperature.

Epidemiology

In addition to their potential pathogenicity, fungi have one fundamental characteristic in common: they are first and foremost **saprophytes**. This means that their existence as a parasite in humans or animals is entirely unnecessary for the completion of their life cycle. They are at most **facultative pathogens,** which only parasitise if they encounter **promoting factors,** whether **systemic** or **local**. Examples of the former are deep candidiasis and aspergillosis in patients with neutropenia and superficial candidiasis and deep cryptococcosis in AIDS patients. Examples of local promoting factors are skin irritations, which predispose to cutaneous and subcutaneous mycoses.

The majority of the causative agents of mycoses are **exosaprophytes.** A patient only develops symptoms following exposure to the natural biotopes or ecological niches of the fungi. Knowledge of these possible sources of infection is therefore important.

Some moulds have a limited geographical distribution. An AIDS patient can catch an infection with the cosmopolitan *Cryptococcus* anywhere in the world but can only acquire an infection with *Talaromyces marneffei* (Previously Penicillium sp.) in Southeast Asia.

Other moulds live in or on humans.

Candida albicans the main causative agent of candidiasis, is an obligate **endosaprophyte.** The normal biotope of this yeast is the gastro-intestinal tract and the oral cavity in particular. Local or systemic **promoting factors** are responsible for the transition from the saprophytic to the parasitic phase.

Malassezia furfur (Pityrosporum ovale) is a **lipophilic** yeast present in everyone as an **episaprophyte** on the skin, which in certain circumstances can become pathogenic.

This may explain why with a few exceptions such as certain dermatophytoses and sporotrichosis, **mycoses** should **not** be considered **infectious**.

Classification

Superficial mycoses

- Tinea (synonym dermatophytoses): infections of skin, hair and nails. Tinea capitis, tinea barbae, tinea corporis, tinea cruris, tinea pedis, tinea unguium (onychomycosis). Examples of anthropophilic dermatophytes:
  - *Epidermophyton floccosum*
  - *Trichophyton mentagrophytes* var. *Interdigitale*
  - *Microsporum langeroni*
  - *Trichophyton rubrum*
  - *Trichophyton schonleini*

- Examples of zoophilic dermatophytes (which can also infect humans):
  - *Trichophyton verrucosum* – cattle
  - *Trichophyton equinum* – horse
  - *Microsporum canis* – cat (dog)
  - *Trichophyton mentagrophytes* var*. mentagrophytes* – rodent

- *Malassezia furfur (Pityrosporum ovale): Pityriasis versicolor*
- Superficial candidiosis: cutaneous, oral, genital. Causative agents: *C. albicans, C. glabrata*, *C. guilliermondii*, *C. krusei*, *C. parapsilosis*, *C. tropicalis*, etc.

Subcutaneous mycoses

- Chromomycosis
  - *Fonsecaea pedrosoi*
  - *Fonsecaea compacta*
  - *Cladosporium carrionii*
  - *Phialophora verrucosa*
- Mycetoma

- *Eumycetoma*
- *Actinomycetoma (not due to fungi)*

Examples of mycetoma:

Red discharge

- *Actinomadura pelletieri*

White or **Yellow discharge**

- *Acremonium strictum*
- *Actinomadura madurae*
- *Aspergillus nidulans*
- *Noetestudina rosatii*
- *Phaeoacremonium krajdeni*
- *Pseudallescheria boydii*

Black discharge

- *Aspergillus terreus*
- *Curvularia lunata*
- *Cladophialophora bantiana*
- *Exophiala jeanselmei*
- *Leptosphaeria senegalensis*
- *Leptosphaeria tompkinsii*
- *Madurella grisea*
- *Madurella mycetomatis*
- *Pyrenochaeta romeroi*
- Sporotrichosis
  - Sporotrix schenckii
- Rhino-entomophtormomycosis
  - *Conidiobolus*
  - *Basidiobolus*

- Lobomycosis
  - *Lacazia loboi*

Deep mycoses

- **Cosmopolitan**
  - Aspergillosis : a few hundred species described. Most relevant examples:
    - *Aspregillus fumigates*
    - *Aspergillus flavus*
    - *Aspergillus niger*
  - Candidiosis, Causative agents: C. albicans, C. glabrata, C. guilliermondii, C. krusei, C. parapsilosis, C. tropicalis, C. kefyr, C. lusitaniae, C. zeylanoides etc.
  - Cryptococcosis
    - *Cryptococcus neoformans*
    - *Cryptococcus gatii*
    - *Cryptococcus albidus*
    - *Cryptococcus uniguttulatus*
  - Pneumocystosis
  - Mucormycosis
  - Phaehyphomycosis
- **Exotic (≠ tropic)**
  - Histoplasmosis
    - *Histoplasma capsulatum* var. *capsulatum*
    - *Histoplasma capsulatum* var. *duboisii*
  - Blastomycosis
  - Penicilliosis
    - *Talaromyces marneffei*
  - Emmonsiosis *(Emmonsia sp.)*
  - Coccidioidomycosis
    - *Coccidioides imitis*
  - Paracoccidioidomycosis
    - *Paracoccidioides brasiliensis*