

## A. CLASSIFICATION OF FUNGI

Fungi are eukaryotic organisms that do not contain chlorophyll, but have cell walls, filamentous structure, and produce spores. These organisms grow as saprophytes and decompose dead organic matter. There are between 100,000 to 200,000 species depending on how they are classified. About 300 species are presently known to be pathogenic for man and animals

There are five kingdoms of living things. The fungi are in the Kingdom Fungi

KINGDOM	CHARACTERISTICS	EXAMPLE
Monera	Prokaryocyte	Bacteria Actinomycetes
Protista	Eukaryocyte	Protozoa
Fungi	Eukaryocyte*	Fungi
Plantae	Eukaryocyte	Plants Moss
Animalia	Eukaryocyte*	Arthropods Mammals Man

\*This common characteristic is responsible for therapeutic dilemma in anti-mycotic therapy

The taxonomy of the Kingdom Fungi is evolving and is controversial. Formerly based on gross and light microscopic morphology, studies of ultra structure, biochemistry and molecular biology provide new evidence on which to base the taxonomy positions. Medically important Fungi are in four phyla.

1. Ascomycota- Sexual reproduction in a sack called an ascus with the production of ascospores
2. Basidiomycota- Sexual reproduction in a sack called basidium with the production of basidiospores
3. Zygomycota- Sexual reproduction by gametes and asexual reproduction with formation of zygospores
4. Mitosporic Fungi (Fungi imperfect)- no recognizable form of sexual reproduction, includes most pathogenic Fungi.

## B. MORPHOLOGY

Pathogenic fungi can exist as yeasts or as hyphae. A mass of hyphae is called mycelia. Yeasts are unicellular organisms and mycelia are multicellular filamentous structures, constituted by tubular cells with cell wall. The yeasts reproduce by budding. The mycelia forms branch and the pattern of branching is an aid to the morphological identification. If the mycelia do not have SEPTA, they are called coenocytic (nonseptate). The terms “hypha” and “mycelium” are frequently used interchangeably. Some fungi occur in both the yeast and mycelial forms. These are called dimorphic fungi.

### Dimorphic Fungi

The dimorphic fungi have two forms

1. YEAST- (Parasitic or Pathogenic form). This is the form usually seen in tissue, in exudates, or cultured in an incubator at 37°C .
2. MYCELIUM- (Saprophytic form). The form observed in nature or when cultured at 26°C. Conversion to the yeast form appears to be essential for pathogenicity. In the dimorphic fungi, fungi are identified by several morphological or biochemical characteristics, including the appearance of their fruiting bodies. The asexual spores may be large (Macroconidia, Chlamydospores), or small (microconidia, blastospores, arthroconidia).

There are four types of mycotic diseases:

1. Hypersensitivity- an allergic reaction to molds and spores
2. Mycotoxicoses- poisoning of man and animals by feeds and food products contaminated by fungi which produce toxin from the grain substrate.
3. Mycetismus- the ingestion of toxin (mushroom poisoning)
4. Infection

We shall be concerned mainly with the last type; pathogenic fungi that cause infections. Most common pathogenic fungi do not produce toxins but they do show physiologic modifications during a parasitic infection ( e.g. increased metabolic rate, modified metabolic pathways and modified cell wall structure). The mechanisms that cause these modifications as well as their significance as a pathogenic mechanism are just being described. Most pathogenic fungi are also thermo tolerant, and can resist the effects of the active oxygen radicals released during the respiratory burst of phagocytes. Thus, fungi are able to withstand many host defenses. Fungi are ubiquitous in nature and most people are exposed to them. The establishment of mycotic infection usually depends on the size of the inoculum and on the resistance of the host. The severity of the infection seems to depend mostly on the immunologic status of the host. Thus, the demonstration of fungi, for example, in blood drawn from an intravenous catheter can correspond to colonization of the catheter, to transient fungemia (i.e. dissemination of fungi through the blood stream), or to a true infection. The physician must decide which is the clinical status of the patient based on clinical parameters, general status of the patient, laboratory results, etc. the decision is not trivial, since treatment of systemic fungal infections requires the aggressive use of drugs with considerable toxicity. Most mycotic agents are soil saprophytes and mycotic diseases are generally not communicable from person-to-person (occasional exceptions: candida and some dematophytes). Outbreaks of disease may occur, but these are due to a common environmental exposure, not communicability. Most of the fungi which cause systemic infections have a peculiar characteristic ecologic niche in nature. This habitat is specific for several fungi which will be discussed later. In this environment, the normally saprophytic organism proliferate and develop. This habitat is also the source of fungal elements and/or spores, where man and animals, incidental hosts, are exposed to the infectious particles. It is important to be aware of these associations to diagnose mycotic diseases. The physicians must be able to elicit a complete history from the patient including occupation, vocation and travel history. This information is frequently required to raise, or confirm, your differential diagnosis. The incidence of mycotic infections is currently increasing (in man) dramatically, due to an

immunosuppressive therapy, and the use of more invasive diagnostic and surgical procedures (prosthetic implants). Fungal diseases are non-contagious and non-reportable diseases in the national public health statistics.

### C. DIAGNOSIS

1. Skin scrapings suspected to contain dermatophytes or pus from a lesion can be mounted in KOH on a slide and examined directly under a microscope.
2. Skin testing (dermal hypersensitivity) used to be popular as a diagnostic tool, but this use is now discouraged because skin test may interfere with serological studies by causing false positive results. It may still be used to evaluate the patient's immunity as well as a population exposure index in epidemiological studies.
3. Serology may be helpful when it is applied to a specific fungal disease: there are no screening antigens for "fungi" in general. Because fungi are poor antigen, the efficacy of serology varies with different fungal infections. The serologic test will be discussed under each mycosis. The most common serological tests for fungi are based on latex agglutination, double immunodiffusion, complement fixation and enzyme immunoassays. While latex agglutination may favor the detection of IgM antibodies, double immunodiffusion and complement fixation usually detect IgG antibodies. Some EIA tests are being developed to detect both IgG and IgM antibodies. There are some tests which can detect specific fungal antigens, but they are just coming into general use.
4. Direct fluorescent microscopy may be used for identification, even on non-viable cultures or on fixed tissue section. The reagents for this test are difficult to obtain.
5. Biopsy and histopathology. A biopsy may be very useful for the identification and as a source of the tissue-invading fungi. Usually the Gomori methenamine silver (GMS) stain is used to reveal the organism which stain black against a green background. The H&E stain does not always tint the organism, but it will stain the inflammatory cells.
6. Culture. A definite diagnosis requires a culture and identification. Pathogenic fungi are usually grown on Sabouraud dextrose agar. It has a slightly acidic pH (5,6), cyclohexamide, penicillin, streptomycin or other inhibitory antibiotic are often added to prevent bacterial contamination and overgrowth. Two cultures are inoculated and incubated separately at 25<sup>0</sup>C and 37<sup>0</sup>C to reveal dimorphism. The cultures are examined macroscopically and microscopically. They are not considered negative for growth until after 4 weeks of incubation.

#### Reference:

Betsy, T and Keogh, J: (2005) Microbiology demystified. Published by the McGraw-Hill Companies, New York, USA.

