VETERINARY MYCOLOGY

Introduction

- Fungi, unlike bacteria, are eukaryotic organisms that lack chlorophyll and absorb all nutrients from the environment. Fungi are ubiquitous and the majority are saprophytic; only a few of the thousands of recognized species are pathogenic for animals or humans.
- Most species that do infect animals are limited, by nutritional requirements and host defenses, to the superficial skin or subcutaneous tissues. However, fungal infections in the immunocompromised host can be very serious.
- Systemic fungal infections are the most serious and some are limited to particular geographical regions. Because fungi are eukaryotic, they are not susceptible to most of the antibiotics used to treat bacterial infections. There are only a few drugs used in the treatment of fungal infections and most of them have some toxicity for mammals.

GENERAL CHARACTERS OF FUNGI

- The fungi that are most commonly isolated as agents of disease in animals are yeasts, dermatophytes, and opportunistic fungi (e.g. *Aspergillus).*

- Fungi are eucaryotic, chemoorganotrophic and spore bearing organisms.
- They are non motile.
- They absorb nutrients and have no photosynthetic activity.
- They reproduce both sexually and asexually.
- The body or vegetative structure of fungus is called as thallus (P: Thalli).
- It varies in size and complexity, ranging from the single cell microscopic yeast to multicellular molds, puff balls and mushrooms.
- Fungi are usually aerobic (Particularly Molds), some yeast, however, are facultatively anaerobic and can obtain energy by fermentation.
- Obligate or strict anaerobic fungi are found in the rumen of the cattle.
- Fungi grow in wide range of temperature between 10°C and 40 °C. Some fungi can grow at temperature of 50°C or even in freezing temperature.
- Optimum temperature is 22 to 30°C (Saprophytic fungi) and for parasitic fungi 30 - 37°C.
- Mostly fungi prefer an acidic pH for their growth. The optimum pH range is between 3.8 to 5.6.
- However, some fungi can grow even in salt water and some can grow in high concentration of solute.
- Some fungi that exist in the mycelial form in nature at room temperature will convert to a yeast form at 37°C in the tissues of animals.
- These fungi are called as dimorphic and the shift is called as YM (Yeast to Mold) shift.

CLASSIFICATION OF PATHOGENIC FUNGI

- Pathogenic fungi can be classified according to
    - Macroscopic Morphology
    - Microscopic Morphology

- Type of Reproduction
- Taxonomy and
- Mycosis

Macroscopic Morphology

- Certain fungus species of veterinary importance are known to multiply through the budding of blastospores (Imperfect yeast); resembling the budding of perfect yeast.
- The budding type of multiplication produces a pasty to mucoid appearance on culture media, resembling appearance of a bacterial culture, these forms are termed as Monomorphic yeasts.
- E. g. *Candida albicans* and other *Candida spp. Cryptococcus neoformans, Geotrichum candidurn, Trichosporon cutaneum*.
- Some species are known to multiply only by sending out germ tubes from the spores.
- These germ tubes develop into long filaments, called hyphae, which may become septate, branched or both, depending upon the species.
- Hyphae develop into a mat of filamentous growth known as mycelium.
- Mycelial growth can be observed macroscopically as a flilamentous (mold) growth shortly after its development commences.
- The hyphae of the mycelium usually give rise to spores in which case the process of development repeats under proper conditions for growth; these type of fungi are termed as Monomorphic molds
  e.g. *Microsporum*, *Trichophyton*, *Aspergillus* and *Penicillium* species.
- A few species of pathogenic importance are known to multiply at 25°C in the manner of the monomorphic molds and to multiply at 37°C in the manner of monomorphic yeasts.
- Such type of species which are known to multiply as either a yeast form or a mold form, depending upon the temperature of Incubation, are termed as dimorphic fungi eg. *Histoplasma capsulatum. Blastomyces dermatitidis, Sporothrix schenckii.*

Microscopic Morphology

- Basic microscopic morphological features pertinent to veterinary importance include:
  - Type of hyphae
  - Type of spores
  - Type of spore bearing structure
- Type of hyphae
  - Septate ; Presence of cross walls in a hyphal filament.
  - Aseptate : Absence of cross walls in a hyphal filament, also known as coenocytic hypha.
  - Pseudohypha: Chain of elongated budding cells that have failed to detach.
- Type of spores
  - Two types of spores are produced by fungi i. e. asexual and sexual
  - t. Asexual spores are of the following types
    - *Macroconidium:* Term referring to large, often multi cellular conidium.
    - *Microconidium:* Small, single celled conidium.
    - *Chlamydospores:* These are thick walled, resistant spores formed by the direct differentiation of the mycelium (i. e. concentration of protoplasm and nutrients) e.g. *Candida albicans*.
    - *Arthrospore:* This is an asexual spore formed by the disarticulation of mycelium e.g. *Geotrichum candidum.*
    - *Blastospore:* A spore produced as a result of budding process the mycelium or from a single spore e. g. *Saccharomyces* spp .

        - *Sporangiospore:* An asexual spore produced by closed, often spherical structure called sporangium e.g. *Rhizopus*.
        - The specialised hypha bearing sporangium is known as sporongiophore and the persisting dome shaped upper portion of the sporongiophore is called columella.
    - Sexual spores are as follows
        - *Ascospores:* A sexual spore characteristic of the true yeasts and *Ascomycetes*.
        - They are produced in a sac like structure called ascus. This ascospore results from the fusion of two nuclei e. g. *Saccharomyces* spp.
        - *Basidiospore:* Sexual spore, characteristic of the class *Basidiomycetes*, produced on a specialised club like structure called basidium.
        - *Zygospore:* A thick walled sexual spore produced through fusion of two similar gametangia found in the class *Phycomycetes*.
        - Gametangium is a structure in which gametes are produced. Gamete : A sexual cell, especially a cell formed in a gametangium.
- Type of spore bearing structure
    - *Conidiophore:* is a stalk like branch of the mycelium on which conidia develop either singly or in numbers e.g. *Penicillium*. These vary from extremely short, near obsolete hyphae to those that are long intricately branched.
    - *Sporangiophore:* is specialised hypha bearing sporangium and the persisting dome shaped upper portion of the sporangiophore is called columella.

Type of Reproduction

- Fungi reproduce asexually or sexually or both depending upon the species and environmental conditions.
    - If a fungus species demonstrate sexual reproduction alone or sexual and asexual reproduction, the fungus is called perfect fungus eg. *Saccharomyces cerevisiae*.
    - If a fungus species demonstrates only asexual reproduction, this fungus is called an imperfect fungus, also known as fungi-imperfecti and these belong to the class *Deuteromycetes*.

Taxonomy

- Class Phycomycetes
    - The *Phycomycetes* are the most primitive class of fungi.
    - They produce broad, aseptate hyphae and reproduce asexually by forming sporangia that contain sporangiospores.
    - Sexual reproduction occurs by means of thick walled resting spores, which can be zygospores or oospores.
- Class Ascomycetes
    - *Ascomycetes* are represented by two morphologically distinct types.
    - The first type has unicellular, round or oval forms reproducing asexually by budding of blastospores.
    - The perfect yeast, genus *Saccharomyces*, represents this type. If conditions are favourable, sexual ascospores are formed.
    - Four or eight ascospores develop within each sac-like enclosure called an ascus. The asci break open to release the ascospores.
    - The second type of *Ascomycetes* have septate hyphae, producing filamentous forms, which reproduce asexually by spores called conidia and sexually by ascopores.
    - In this type, the asci are usually enclosed within a tightly meshed network of hyphae (mycelia) called perithecium.

- Class Basidiomycetes
  - *Basidiomycetes* develop sexual basidiospores from specialized club shaped structures called basidia.
  - Each basidium usually bears four exogenous basidiospores resembling toes on a foot.
- Class Deuteromycetes
  - The majority of pathogenic fungi belong to this class. *Deuteromycetes* (fungi imperfecti) are composed of those fungi that lack a demonstrable means of sexual reproduction, therefore, are considered imperfect.
  - The *Deuteromycetes* are represented by two morphologically distinct types: a filamentous (mold) form and an imperfect yeast form resembling the perfect yeast, *Saccharomyces*.
  - Asexual spores of two major types are produced in this class. These are the thallospores and conidia.
  - The thallospores are formed by a change in portions of the thallus or body of the fungus and include the arthrospores, blastospores and chlamydospores.
  - The conidia are produced by abstrictions from specialized hyphae called conidiophores.
  - Large conidia mav be called macroconidia and small conidia as microconidia.

Mycosis

- Mycoses can be divided into four categories according to the tissues usually invaded.
- Superficial
  - The etiological agents of the superficial mycoses are confined to the outermost layers of skin and hair.
  - The superficial mycoses are less serious than the other mycoses e.g. *Trichosporon cutaneum*.
- Cutaneous
  - Most of the etiological agents of the cutaneous mycoses possess the special ability to invade and destroy keratin in skin, hair and nails, e.g. *Candida albicans, Trichophyton, Microsporum, & Epidermophyton* spp.
- Subcutaneous
  - The agents responsible for subcutaneous mycoses are more serious than the cutaneous mycoses and they invade primarily the muscle tissue, e.g. *Rhinosporidium seebri, Sporothrix schenckii.*
- Systemic
  - The agents of systemic mycoses invade deep tissue and create symptoms resembling other diseases of the particular tissues or organ invaded.
  - Systemic mycoses may also have cutaneous manifestations.
  - The systemic mycoses are the most serious of the mycoses.
  - E.g. Candidiasis, cryptococcosis, histoplasmosis, geotrichosis, blastomycosis etc.,

PREDISPOSING FACTORS FOR FUNGAL INFECTIONS

- Prolonged antibiotic therapy. Antibiotics may lower host resistance in some ways, but the best known effect is through alteration of the normal bacterial flora.
- The most common fungal infection resulting from antibiotic treatment is intestinal candidiasis.
- Immunosuppressive treatment and drugs. Drugs that interfere with inflammation and humoral and cellular immunity, make animals particularly more susceptible to opportunistic fungal infections.
- Radiation therapy is particularly toxic for antibody-producing cells.

- Infectious and noninfectious diseases (e.g. cancer), and pregnancy can reduce host resistance and make animals more susceptible to fungal infections.
- Genetic immune deficiencies.
- Environmental factors, such as trauma, general lowered resistance due to stress, a moist environment and exposure to a large number of organisms.

CHARACTERISTIC OF FUNGUS INFECTIONS

- Most fungal diseases are not contagious or zoonotic; an exception isdermatophytosis.
- Most fungi are opportunistic and demonstrate relatively low invasiveness and lowvirulence for healthy hosts.
- Host predisposed on exposure to a large number of spores.
- Fungal infections often result in a chronic, granulomatous, inflammatory processsimilar to that seen in mycobacterial disease.
- Due to the chronic nature of fungal infections, cell-mediated immunity is usuallymore important than humoral immunity in regard to protection.
- Animals exposed or infected by some fungi may develop a hypersensitivity reaction.
- Most fungal infections are asymptomatic or self-limited.
- Most fungi that cause disease in animals have no recognized sexual state.

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