DERMATOPHYTOSIS

Learning objectives

To know in detail about,

- Diseases caused by *Dermatophilus species*
- Developmental cycle of *Dermatophiuls congolensis*
- Tram-track appearance and strawberry foot rot
- Pathogenesis of mycotic dermatitis n sheep
- Haalstra's method for the isolation of *Dermatophilus congolensis*
- Different diagnostic methods of dermatophilosis

INTRODUCTION

- Dermatophytosis is an infection produced by molds capable of parasitizing only keratinized epidermal structures: superficial skin, hair, feathers, horn, hooves, claws and nails.
- Those that have a sexual reproductive phase belong to the *Ascomycetes*. Dermatophyte infections are called ringworm (tinea).
- The dermatophytes, more than any other group of fungi, have developed a close host-parasite relationship with animals.
- Many dermatophytes have evolved into obligate parasites.
- Dermatophyte infections are contagious and a zoonotic source of infections for humans.
- Infections from animal to human are referred to as zoophilic, while those from soil to animal or human are referred to as geophilic.
- The most common animal dermatophytes are
    - Zoophilic pathogens

Pathogens	Animals affected
Trichophyton mentagrophytes	All domestic animals
Trichophyton verrucosum	Cattle and sheep
Trichophyton gallinae	Fowl
Trichophyton equinum	Horses
Microsporum canis	predominately dogs and cats primates and horses also
Microsporum nanum	Swine and humans

    - Geophilic Pathogen: *Microsporum gypseum* – mainly affects dogs, cats, horses, and humans.
- Rare causes of animal dermatophytes are the anthropophilic, globally prevalent *Trichophyton rubrum*, *Microsporum audouinii*, *Trichophyton schoenleinii, Microsporum cookei, Microsporum distortum, Trichophyton megnini*.

HISTORY AND HABIT

History

- Ringworm, the common name for dermatophyte infections, has been described from the earliest historical times.

- The name came about due to the fact that the fungus grows equally in all directions and forms lesions with circular or ring forms.
- The Romans associated the disease with insects and referred to it as tinea, meaning small insect.
- Tinea is still used to refer to different clinical settings of the disease (e.g., tinea pedis - ringworm of the feet).
- In 1910 Sabouraud published a detailed work on systematic and scientific studies of the dermatophytes. There are currently 37 species of dermatophytes.
- In 1959 the sexual state of some of the dermatophytes was identified, and they are now classified in the class *Ascomycetes*.
- In 1958 Gentles published the first report on the oral administration of griseofulvin, which cured experimental dermatophytosis in a guinea pig.

Natural habitat

- The dermatophytes are closely related in appearance, physiology, and antigenicity.
- Although the soil is rich with dermatophytes, most of the agents that cause animal disease are obligate parasites of animals.
- In general, the more chronic the infection and the more adapted the parasite is to the host, the less severe the inflammatory response will be.
- *M. gypseum* is a natural soil inhabitant that is a common cause of dermatophytosis, while most of the other common animal pathogens are normally found only on animals.

MORPHOLOGY

- In their nonparasitic phase, including culture, dermatophytes produce septate, branching hyphae collectively called mycelium.
- The asexual reproductive units (conidia) are found in the aerial mycelium. These units may be either macroconidia or microconidia.
- Shape, size, structure, arrangement and abundance of conidia are diagnostic criteria.
- A general rule that can be applied (but not always) is that most species in the genus *Microsporum* produce predominately macroconidia, and most *Trichophyton species*produce predominately microconidia with few or no macroconidia.
- Hyphal peculiarities — spirals, nodules, rackets, chandeliers and chlamydoconidia — are more common in some species than others, but they are rarely diagnostic.
- Pigmentation is useful in dermatophyte differentiation.
- In tissue sections, arthroconidia can often be identified. This parasitic phase arthrospore can remain infectious for years.
- Except in size ranges, which overlap among dermatophyte species, arthroconidia are indistinguishable from species to species.
- Chlamydoconidia are also commonly seen in some dermatophytes *in vitro* and their presence may be of use diagnostically in the absence of other conidia.
- Sexual spores (ascospores) are absent in the parasitic phase.

CULTURAL CHARACTERISTICS

- The most common media for propagating dermatophytes are dermatophyte test medium (DTM) or Sabouraud's dextrose agar, a 2% agar containing 1% peptone and 4% glucose.
- Its acidity (pH 5.6) renders it mildly bacteriostatic and selective.
- The selectivity is enhanced by addition of cycloheximide (500µg/ml), which inhibits other fungi, and gentamicin and tetracycline (100 µg/ml of each), or chloramphenicol (50 µg/ml).
- Dermatophytes are aerobes-and nonfermenters. Some attack proteins and deaminate amino acids.
- They grow optimally at 25°C to 30°C and require several days to weeks of incubation.
- Some dermatophytes in skin and hair (but not in culture) produce a green fluorescence due to a tryptophan metabolite that is visible under a Wood's light. Of animal dermatophytes, only *Microsporum canis* produces this reaction.

PATHOGENESIS

- Proteolytic enzymes (elastase, collagenase, keratinase) may determine virulence, particularly in severe inflammatory disease.
- The dermatophytes are highly specialized for utilizing keratin as food source. Localization in keratinized epidermis has been attributed to the lack of sufficient available iron elsewhere.
- Keratinase is therefore a clearly recognized virulence factor for dermatophytes.
- It is thought that those dermatophytes that are highly species-specific have a keratinase that can only hydrolyze keratin from a particular animal species, whereas those with more broad acting keratinases can invade the skin of many different species (e.g. *T. mentagrophytes*).
- The infectious unit conidia enters the skin through an abrasion, germinate and hyphae begin to grow in the stratum corneum.
- Portions of mycelium differentiate into arthroconidia. This growth pattern in the hairless skin predominates with some dermatophytes (*M. nanum*, *T. rubrum*).
- Hair invasion, which is prominent in most animal ringworm, begins with germination of a spore near a follicular orifice.
- The hyphae invade the hair follicle and enter the cortex of the hair by dissolving the keratin.
- The hyphae and conidia are carried to the surface by the growing hair, which often breaks off.
- Hair invasion may be endothrix (arthroconidia develop within the hair shaft only and the cuticle remains intact) or ectothrix (arthroconidia develop outside the hair shaft and hyphae are within the hair shaft; the cuticle is destroyed).

PATHOGENICITY

Symptoms

- Although not fatal, dermatophytosis can be a cause of significant economic loss and a source of infection for man.
- One of the first clinical signs is loss of hair, followed by an inflammatory reaction of the skin due to the host response.
- Dermatophytosis occurs more commonly in very young, old, or sick animals and most often in stabled rather than pastured animals.
- The peak incidence occurs in the winter. The characteristic lesion is a hyperkeratosis with septate hyphae and arthroconidia in the stratum corneum.
- Invasion of the hair causes the shaft to become weak and break, resulting in circular, scaly areas of alopecia with or without crust formation.
- Arthroconidia within or outside the hairshaft are also referred to as arthrospores.
- Manifestations range from erythema to vesiculopustular reactions and suppuration.
- Mild forms are seen in *T. verrucosum* infection of calves. Severe reactions are typical in *T. mentagrophytes* infection of dogs and *M. gypseum* infection of horses.
- Local plaques (kerion) may resemble certain skin tumors, especially in dogs.
- The inflammatory reaction may arrest the mycotic infection but become the primary problem through secondary suppurative bacteria! infection.
- The roughly circular pattern of the lesions and their inflamed margins suggested the terms ringworm and tinea (Latin for worm). Different tineas are
    - *Tinea barabe* – beard
    - *Tinea capitis* – scalp
    - *Tinea corporis* – body
    - *Tinea cruris* – groin
    - *Tinea favosa* – favus
    - *Tinea imbricata* and *Tinea manum* – hands
    - *Tinea pedis* – feet
    - *Tinea unguium* – nails

Lesions

- Lesions are very similar in different animal species.
- The most common areas of infection on dogs and cats are the head and extremities.
- In horses and sheep the neck and girth are most often infected.
- In cattle, the most common sites are the head and neck.
- In fowl, the disease is referred to as fowl favus or white comb, due to the white, moldy crusts that develop on the comb and wattle.
- Hyphae that invade the stratum corneum induce a hyperkeratosis.
- The resulting inflammatory response by the host is most intense at the area of recent invasion.
- The infection spreads in all directions, giving a ring-like appearance.
- The most active site of infection is at the periphery, while the central area begins to heal.
- Therefore, specimens for culture and examination should always be collected from the edge of the lesion.
- The living skin is not infected. The optimal growth temperature of dermatophytes is 30° C; most grow poorly, if at all at 37° C and, therefore cannot infect deeper tissues.
- The host may develop a hypersensitivity to the invading fungus that may result in vesicular lesions developing in various parts of the body.
- These "id" reactions are thought to be due to fungi or their products disseminating in the body and to an immune reaction.
- The resulting hypersensitivity reaction to the fungus may be delayed-type, or immediate.
- Infections due to *M. canis* are often associated with kerions, which are vesicles in and around the lesion.

DIAGNOSIS

Diagnosis

- Based on Direct Examination
  - Fluorescence of hairs is useful for identification of hairs that may be infected with dermatophytes.
  - In 50% to 70% of cases, hairs and skin scales infected with *M. canis* or *M. audouinii* may emit a bright greenish fluorescence under ultraviolet light
- Based on Microscopic examination
  - Skin scrapings and hair are examined microscopically for the presence of hyphae and arthroconidia.
  - The scraping should include material from the margins of any lesion and the full thickness of the keratinized epidermis.
  - The hair is plucked, so as to include the intrafollicular portion.
  - The sample is placed on a slide, flooded with 10% to 20% KOH or NaOH , with a cover slip, and heated gently.
  - Microscopic examination should begin under low power and subdued light.
  - Infected hairs are encased in an irregular sheath of arthrospores that may double their normal thickness.
  - At higher magnification of such hairs, individual, spherical arthroconidia are recognizable.
  - In hairless skin, branching hyphae and chains of arthroconidia occur.
- Based on culture
  - Hair and skin scrapings should be inoculated to dermatophyte test medium (DTM) and Sabouraud dextrose agar medium, with and without cycloheximide and chloramphenicol, and incubated at 25-30° C for up to 4 weeks. Samples suspected of containing *T. verrucosum* are incubated at 37°C.
  - The DTM medium will turn red as the dermatophyte is growing, and the fungus itself will usually be hyaline and fluffy.
  - Although selective, other molds may grow on DTM and therefore idenification should be confirmed by microscopy.

- Very long, narrow hyphae with distinctive shapes and micro or macroconidiaare indicative of dermatophyte infection.

Differential diagnosis

- Differentiate from Insect bites, Urticaria, bacterial infections, seborrheic dermatitisand interdigital dermatitis.

TREATMENT AND PREVENTION

Treatment

- Ringworm generally regresses spontaneously within a few weeks or months, unless complicated by secondary infections or constitutional factors.
- The agents may persist after clinical cure.
- Combined topical and systemic treatment is often preferable. Of two systemic agents available, griseofulvin and ketoconazole, the latter is more costly and less proven.
- Both drugs are given orally and are relatively well tolerated.
- For small animals, griseofulvin given orally is most beneficial for severe infections.
- The drug is incorporated into the keratin of the tissue and renders the skin resistantto infection.
- The fungus is shed with the dead skin, and therefore requires prolonged therapy (given for at least a month, or 2 weeks), particularly if the infection is in the nail. Some toxicity may occur.
- Ketoconazole and fluconazole may also be used, but would be very expensive.
- Topical treatments can be used for large animals and for skin infections, but are not useful for nail infections.
- These treatments include salicylic and benzoic acids, iodine, natamycin-s, and imidazole derivatives. Infections can recur.

Prevention

- Wood light screening of scalps and suspected animal reservoirs. (Cats and dogs), hairbrush technique for culture of none fluorescing scalps, improve hygiene and discourage sharing of clothing and accessories.
- In cattle, vaccines for *T. verrucosum* have been reported to be successful for 3-5years.

However, this has not been shown with vaccines to other dermatophytes.