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Dermatophytosis
Ringworm
Tinea
Dermatomycosis

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Overview

- Organisms
- History
- Distribution
- Transmission
- Disease in Humans
- Disease in Animals
- Prevention and Control

In today's presentation we will cover information regarding the organisms that cause dermatophytosis and their epidemiology. We will also talk about the history of the disease, how it is transmitted, species that it affects (including humans) and clinical signs observed. Finally, we will address prevention and control measures for dermatophytosis.

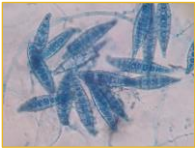
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THE ORGANISMS

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Organisms

- Fungi
 - *Microsporum*, *Trichophyton*
 - Animal pathogens
 - *Epidermophyton*
 - Human pathogen
- Classification
 - Zoophilic
 - Anthropophilic
 - Geophilic



Dermatophytosis is caused by fungi in the genera *Microsporum*, *Trichophyton* and *Epidermophyton*. These organisms, called dermatophytes, are the pathogenic members of the keratinophilic (keratin digesting) soil fungi. *Microsporum* and *Trichophyton* are human and animal pathogens. *Epidermophyton* is a human pathogen.

The most common system to classify dermatophytes is as follows:

- **Zoophilic** dermatophytes are mainly found in animals but can be transmitted to humans.
- **Anthropophilic** dermatophytes are mainly found in humans and are very seldom transmitted to animals.
- **Geophilic** dermatophytes are found mainly in soil, where they are associated with decomposing hair, feathers, hooves and other keratin sources. They infect both humans and animals.

[Photo: Microscopic morphology of *Microsporum canis* macroconidia. Source: Roberto Galindo/Wikimedia Commons]

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Zoophilic Organisms*	
<ul style="list-style-type: none"> • <i>Microsporium canis</i> • <i>M. gallinae</i> • <i>M. gypseum</i> • <i>M. equinum</i> • <i>M. nanum</i> • <i>M. persicolor</i> 	<ul style="list-style-type: none"> • <i>Trichophyton equinum</i> • <i>T. mentagrophytes</i> • <i>T. simii</i> • <i>T. verrucosum</i>

Zoophilic species (found in animals) include:

- *Microsporium canis*
- *M. gallinae*
- *M. gypseum*
- *M. equinum*
- *M. nanum*
- *M. persicolor*
- *Trichophyton equinum*
- *T. mentagrophytes*

Several varieties of *T. mentagrophytes* exist. Some are important pathogens in both animals and humans; others are mainly human pathogens. They include:

- *T. simii*
- *T. verrucosum*

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HISTORY

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History
<ul style="list-style-type: none"> • 30 A.D.: First historical reference • Terminology <ul style="list-style-type: none"> - Tinea - Ringworm • 19th century: Mycotic etiology described • Dermatophytes most common fungal pathogens in the U.S.

Dermatophytes have likely existed for millions of years; however, the first historical reference did not come until 30 A.D., when Roman encyclopedist Aulus Cornelius Celsus described a “suppurative infection of the scalp” that was attributed to a dermatophyte. In that era, dermatophytes were described as “tineas.” The term “ringworm” emerged later, probably around the 16th century. In the 19th century, the mycotic etiology of these skin infections was finally described. Dermatophytes remain the most common fungal pathogens (except finger onychomycosis due to *Candida*) in the U.S.

Sources: Libero A. *Natural history of the dermatophytes and related fungi*. Mycopathologia. 1974;53(1-4): 93-110.

Seebacher C., Bouchara J.P., Mignon B. *Updates on the epidemiology of dermatophyte infections*. Mycopathologia. 2008;166(5-6): 335-352.


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GEOGRAPHIC DISTRIBUTION

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Geographic Distribution

- Optimal conditions
 - Tropics/subtropics
 - Warm, humid environment
- Some worldwide
 - *M. canis*, *M. nanum*, *T. mentagrophytes*, *T. verrucosum*, *T. equinum*
- Some regionally limited



Dermatophytes grow best in warm and humid environments and are, therefore, more common in tropical and subtropical regions. The geographic distribution varies with the organism. *M. canis*, *M. nanum*, *T. mentagrophytes*, *T. verrucosum* and *T. equinum* occur worldwide. *T. simii* (found in monkeys) occurs only in Asia, and *T. mentagrophytes* var. *erinacei* is limited to France, Great Britain, Italy and New Zealand. Photo: Tropical and subtropical regions of the world shown in dark green and medium green colors.

[Photo: Tropical and subtropical desert climates. Source: Encyclopedia Britannica Online.]


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TRANSMISSION

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Transmission

- Contact with:
 - Arthrospores
 - Asexual spores formed in the hyphae of the parasitic stage
 - Conidia
 - Sexual or asexual spores formed in the "free-living" environmental stage



Infection occurs by contact with arthrospores (asexual spores formed in the hyphae of the parasitic stage) or conidia (sexual or asexual spores formed in the "free living" environmental stage).


[Photo: macroconidia of *Microsporum canis*. J. Michael Miller/CDC via American Society for Microbiology at <http://www.asm.org/division/c/fungi.htm>]

<p>S I d e 1 2</p>	<p style="text-align: center;">Transmission</p> <ul style="list-style-type: none"> • Growing hairs or skin are infected <ul style="list-style-type: none"> - Contains essential nutrients • Modes of transmission <ul style="list-style-type: none"> - Contact with infected animals/humans - Airborne hairs/scales - Fomites - Soil 	<p>Infection usually begins in a growing hair or the stratum corneum of the skin. Dermatophytes do not generally invade resting hairs, since the essential nutrients they need for growth are absent or limited. Hyphae spread in the hairs and keratinized skin, eventually developing infectious arthrospores. Transmission between hosts usually occurs by direct contact with a symptomatic or asymptomatic host, or direct or airborne contact with its hairs or skin scales. Infective spores in hair and dermal scales can remain viable for several months to years in the environment. Fomites such as brushes and clippers can be important in transmission. Geophilic dermatophytes are usually acquired directly from the soil rather than from another host.</p>
<p>S I d e 1 3</p>	<p style="text-align: center;">DISEASE IN HUMANS</p>	
<p>S I d e 1 4</p>	<p style="text-align: center;">Clinical Signs</p> <ul style="list-style-type: none"> • Incubation period: 1 to 2 weeks • Dermatophytes grow only in keratinized tissues <ul style="list-style-type: none"> - Hair, nails, outer skin layers • Clinical signs vary by region affected <ul style="list-style-type: none"> - Pruritus - Skin lesions - Hair loss 	<p>Dermatophytes generally grow only in keratinized tissues such as hair, nails and the outer layer of skin; the fungus usually stops spreading where it contacts living cells or areas of inflammation. Mucus membranes are not affected. The clinical signs may vary, depending on the region affected. In humans, pruritus is the most common symptom. The skin lesions are usually characterized by inflammation that is most severe at the edges, with erythema, scaling and occasionally blister formation. Central clearing is sometimes seen, particularly in tinea corporis; this results in the formation of a classic “ringworm” lesion. On the scalp and facial hair, there may be hair loss. In humans, dermatophytoses are referred to as “tinea” infections, and are named with reference to the area of the body involved.</p>
<p>S I d e 1 5</p>	<p style="text-align: center;">Morbidity and Mortality</p> <ul style="list-style-type: none"> • Infections are common <ul style="list-style-type: none"> - Exact prevalence unknown - More common in children • Most infections not serious <ul style="list-style-type: none"> - Immunosuppressed individuals - Atypical, locally aggressive lesions 	<p>Although dermatophyte infections are known to be common, their prevalence is unknown as this disease is not notifiable and many infections are treated with over-the-counter drugs. Infections are more common in children than adults. Most dermatophyte infections are not serious in healthy persons; however, opportunistic bacteria can cause cellulitis in skin damaged by interdigital fungal infections. These infections are a particular concern in diabetics. Dermatophytosis is more serious in those who are immunosuppressed. These individuals may have atypical and locally aggressive dermatophyte infections, including extensive skin disease, subcutaneous abscesses, and disseminated disease.</p>

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Tinea capitis

- Children
- Hair and scalp
- Areas of alopecia
- May be suppurative
- Lymph nodes may be enlarged
- Anthropophilic and zoophilic causes
 - *T. tonsurans* most common




Tinea capitis, most often seen in children, is a dermatophyte infection of the hair and scalp. *Tinea capitis* begins with a small papule, which spreads to form scaly, irregular or well-demarcated areas of alopecia. The cervical and occipital lymph nodes may be enlarged. A kerion, a boggy, inflammatory mass, may also be seen; this reaction is usually followed by healing. Suppurative lesions are often seen when the infection is caused by zoophilic dermatophytes. Both anthropophilic and zoophilic dermatophytes can cause *tinea capitis*. In the U.S., it is most often caused by the anthropophilic dermatophyte *T. tonsurans*. Most common agents*: *M. audouinii*, *M. canis*. Other agents: *M. ferrugineum*, *M. gypseum*, *M. nanum*, *M. persicolor*, *T. megninii*, *T. mentagrophytes*, *T. schoenleinii*, *T. soudanense*, *T. verrucosum*, *T. violaceum*.

[Photo: An individual with “ringworm”, or *tinea capitis* of the scalp caused by *Microsporum gypseum*. Source: CDC Public Health Image Library]

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Tinea corporis

- Classic “ringworm”
- Trunk, extremities, face
- Elevated, scaly, pruritic lesions with erythematous edge
- Anthropophilic and zoophilic causes
 - *T. rubrum* most common



Tinea corporis, or ringworm, occurs on the trunk, extremities and face. It is characterized by single or multiple scaly annular lesions with a slightly elevated, scaly and or erythematous edge, sharp margin and central clearing. Follicular papules, pustules or vesicles may be found on the borders of the lesion. Lesions may be variably pruritic. Both zoophilic and anthropophilic dermatophytes are common in children, and on the neck and wrists of adults in contact with the child. In other adults, *tinea corporis* is often the result of chronic infection with *T. rubrum*, an anthropophilic dermatophyte. In many people, untreated *tinea corporis* resolves within a few months, particularly if it is caused by a zoophilic or geophilic organism. Most common agents*: *T. rubrum*, *M. canis*, *M. tonsurans*, *T. verrucosum*. Other agents: *E. floccosum*, *M. audouinii*, *M. gypseum*, *M. nanum*, *M. persicolor*, *T. equinum*, *T. mentagrophytes*, *T. raubitschekii*, *T. schoenleinii*, *T. violaceum*.

[Photo: A ringworm lesion on the arm, or *tinea corporis*, due to *Trichophyton mentagrophytes*. Source: CDC Public Health Image Library]

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Tinea barbae

- Beard and mustache area
- Scaling, follicular pustules
- Erythema
- Anthropophilic or zoophilic causes
 - *T. verrucosum* most common




Tinea barbae is an infection of the hairs and skin in the beard and mustache area, and is usually seen in men. The lesions may include scaling, follicular pustules and erythema. *Tinea barbae* can be caused by zoophilic or anthropophilic dermatophytes. Farm workers are often affected. Most common agents*: *T. verrucosum*. Other agents: *M. canis*, *T. megninii*, *T. mentagrophytes*, *T. rubrum*, *T. violaceum*.

[Photo: Ringworm on the bearded areas of face and neck, known as “*tinea barbae*”, or “barber’s itch”. Source: CDC Public Health Image Library]

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Tinea faciei

- Non-bearded parts of face
- Pruritic
- May resemble *tinea corporis*
- Atypical presentation
 - Often confused with other skin diseases
- *T. tonsurans* most common



Tinea faciei is seen on the non-bearded parts of the face. The lesions are usually pruritic; itching and burning may become worse after exposure to sunlight. Some lesions may resemble those of *tinea corporis*; others may have little or no scaling or raised edges. In some cases, the areas of erythema are indistinct. Due to the atypical presentation, *tinea faciei* is often confused with other skin diseases that affect the face. Most common agents*: *T. tonsurans* in North America; *T. mentagrophytes* and *T. rubrum* in Asia.

[Photo: A child with a ringworm (tinea) fungal infection on the left side of his face and left ear. Source: CDC Public Health Image Library]

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Tinea cruris


- Groin
- Burning and pruritus
- Pustules and vesicles at active edge of infected area
- Red scaling lesions with raised borders
- Usually anthropophilic
 - *E. floccosum*

Tinea cruris is an infection of the groin, usually caused by anthropophilic dermatophytes. The symptoms include burning and pruritus. Pustules and vesicles at the active edge of the infected area, along with maceration, are found in a background of red, scaling lesions with raised borders. Most common agents*: *E. floccosum*, *T. rubrum*. Other agents: *M. nanum*, *T. mentagrophytes*, *T. raubitschekii*.

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Tinea pedis

- "Athlete's foot"
- Fissures, scales, and maceration in the toe web
- Scaling of soles
- Usually anthropophilic
 - *T. rubrum* most common



Tinea pedis (Athlete's foot) is an infection of the foot, characterized by fissures, scales and maceration in the toe web, or scaling of the soles and lateral surfaces of the feet. Erythema, vesicles, pustules and bullae may also be present. It is usually caused by anthropophilic dermatophytes. Most common agents*: *T. rubrum*, *T. mentagrophytes* var *interdigitale*, *E. floccosum*. Other agents: *M. persicolor*, *T. raubitschekii*, *T. violaceum*.

[Photo: A patient with ringworm of the foot (tinea pedis) due to the dermatophytic fungus, *Trichophyton rubrum*. Source: CDC Public Health Image Library]

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Tinea manuum

- Hands
- Palms diffusely dry, scaly, and erythematous
- Usually anthropophilic
 - May be an extension of Athlete's foot
 - *T. rubrum* most common
- Occasionally zoophilic

Tinea manuum is a dermatophyte infection of one or, occasionally, both hands. In this form, the palms become diffusely dry, scaly and erythematous. It is most often caused by anthropophilic dermatophytes (cases may be an extension of Athlete's foot) but is occasionally caused by zoophilic organisms. Most common agent*: *T. rubrum*. Other agents: *E. floccosum*, *M. canis*, *M. gypseum*, *T. mentagrophytes*, *T. verrucosum*.

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Tinea unguium

- Nails
- Thickened, discolored, broken
- Nail plate may separate from nail bed
- Anthropophilic or zoophilic
 - *T. rubrum* most common



Tinea unguium is a dermatophyte infection of the nail. It is characterized by thickened, discolored, broken and dystrophic nails. The nail plate may be separated from the nail bed. It can be caused by anthropophilic or zoophilic dermatophytes. Most common agents*: *T. rubrum*, *T. mentagrophytes* var *mentagrophytes*. Other agents: *E. floccosum*, *T. tonsurans*, *T. violaceum*.

[Photo: Onychomycosis due to *Trichophyton rubrum*, right and left great toe. Source: CDC Public Health Image Library]

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DISEASE IN ANIMALS

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Species Affected

- All domestic animals are susceptible to dermatophytes
 - Dogs and cats
 - Cattle
 - Sheep and goats
 - Horses
 - Swine
 - Rodents, rabbits
 - Birds

All domestic animals are susceptible to dermatophytes. The most common fungi vary with the host.

- Dogs and cats: *M. canis* is the most common species, particularly in cats. *M. gypseum* and *T. mentagrophytes* are found occasionally. Other species are rare.
- Cattle: *T. verrucosum* is the most important species. Species found occasionally include *T. mentagrophytes*, *T. equinum*, *M. gypseum*, *M. nanum* and *M. canis*.
- Sheep and goats: *T. verrucosum* is the most common species but *M. canis* outbreaks have also been reported.
- Horses: *T. equinum* and *M. equinum* are the most important species. *M. gypseum*, *M. canis* and *T. verrucosum* are seen occasionally.
- Swine: *M. nanum* is the most important agent. This dermatophyte is rarely zoonotic.
- Rodents: Varieties of *T. mentagrophytes* are common in rodents. *Microsporum* species, including *M. persicolor*, are seen occasionally.
- Rabbits: *T. mentagrophytes* is the most important species.
- Birds: *T. gallinae* is the usual agent in birds, including poultry, canaries and pigeons. This dermatophyte is rarely zoonotic. *M. gypseum* and *T. simii* infections are seen occasionally.

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Clinical Signs

- Incubation period: 7 days to 4 weeks
- As in humans, dermatophytes grow only in keratinized tissues
- Clinical signs
 - Alopecia
 - Scaling, crusts
 - Erythema, pruritus
 - "Ringworm" appearance uncommon

Dermatophytes usually grow only in keratinized tissues such as hair, nails and the outer layer of skin; the fungus usually stops spreading where it contacts living cells or areas of inflammation. Mucus membranes are not affected. Dermatophyte lesions are characterized by areas of alopecia, scaling, crusts, erythema and pruritus, present to varying degrees. Occasionally, the dermatophytes die at the center of a lesion and that area resolves, leaving a circular "ringworm" lesion. In animals, this pattern is relatively uncommon. Hairs in the affected area are usually brittle and break near the skin surface, often giving the lesion a "shaved" appearance; truncated hair shafts may be seen through the scales and crusts.

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Morbidity and Mortality


- Small animals
 - Prevalence rates vary widely
 - Cats > dogs
 - Subclinical infection in cats
- Livestock
 - Cold climates, animal condition, grooming behaviors
 - Young > old
- Generally self-limiting

Among small animals, the prevalence rates reported in various studies vary widely. In general, dermatophytes are thought to be carried asymptotically more often by cats than dogs. Infection rates between 6% and 88% have been reported in felines. Others feel that subclinical dermatophyte infections are very common, particularly in cats. Among livestock, dermatophytoses are particularly common in cold climates where animals are stabled for long periods of time. Whether an animal becomes infected, after contact with a dermatophyte, may depend on the animal's age, the condition of its exposed skin, and grooming behavior. Young animals are more likely to have symptomatic infections. Dermatophytosis is also more common when animals are immunosuppressed, have poor nutrition or are kept in high density populations. Most infections in healthy animals heal spontaneously within one to a few months. Infections can be more persistent or widespread in young or sick animals, and in some longhaired cats.

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Dogs

- Puppies
- Small circles of alopecia
- Pale skin scales in center
- Develops a crust in later stages
- *M. canis* most common
- Usually self-limiting




In dogs, dermatophytosis is seen most often in puppies. It is uncommon in adult dogs unless they are immunosuppressed. The lesions may appear on any part of the body and usually consist of small circular areas of alopecia; the hairs are typically broken at the base, giving the appearance of the area having been shaved. The center of the lesion usually contains pale skin scales, giving it a powdery appearance, and the edges are generally erythematous. In later stages, the lesion is often covered by a crust and the edges are swollen. Onychomycosis can occur concurrently. Dermatophytosis is usually self-limiting in dogs.

[Photo: (Top) A dog with a ringworm lesion on its muzzle. Source: Clearly Lake Veterinary Hospital; (Bottom) A dog with multiple areas of alopecia due to dermatophytosis. Source: University of Tennessee College of Veterinary Medicine (www.vet.utk.edu)]

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Cats

- Often subclinical
 - Longhaired cats
- Kittens symptomatic
- Focal alopecia
- Grooming behaviors spread infection
- *M. canis* most common
- Self-limiting (short-haired cats)




Many infected cats have few or no lesions. Longhaired adult cats, in particular, can be subclinical carriers; in some cases, the cat may have minimal lesions consisting of patchy areas of short stubble, alopecia, scaly patches or erythematous plaques, visible only on close inspection. Symptomatic cases tend to be seen in kittens, with the early lesions found on the face, ears and paws. Generally, the lesions consist of areas of focal alopecia, with scaling and crusting containing only a few broken hairs. The cat's grooming behavior can spread the infection to the entire body. Onychomycosis may also be seen concurrently; the nails may be opaque, with whitish mottling, and shredding of the nail surface. The lesions are usually self-limiting within a few weeks to a few months in short-haired cats but may persist, either symptomatically or asymptotically, in long-haired cats.

[Photo: A kitten with alopecia (hair loss) on its ears due to dermatophytosis. Source: Dr. James Noxon, Iowa State University/CFSPH]

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Cattle

- Small focal lesions to extensive, generalized skin involvement
- Gray-white, crusty dry areas
- Alopecia
- *T. verrucosum* common
- Usually self-limiting



In cattle, the severity of disease varies, from small focal 1 cm lesions to extensive generalized skin involvement. Most often, the disease appears as nonpruritic periocular lesions in calves. Cows and heifers may have lesions more often on the chest and limbs, and bulls on the dewlap and intermaxillary skin. The initial lesions are discrete, grayish-white, crusty dry areas with a few brittle hairs. Some areas may become suppurative and thickly crusted. Lesions resembling light brown scabs may also be seen; when these scabs fall off, they leave an area of alopecia. The lesions usually resolve spontaneously in 2 to 4 months.

[Photo: Multiple raised pale tan crusted lesions due to dermatophytosis on the skin of a cow. Source: Armed Forces Institute of Pathology/CFSPH]

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Horses

- Most lesions found in areas of contact with saddles or other tack
- Pruritus
- Alopecia, thickened skin
- May resemble papular urticaria
- *T. equinum* most common


In horses, most dermatophyte lesions are found in areas of contact with saddles or other tack. *T. equinum* lesions are usually pruritic, with exudative lesions and areas of hairless, thickened skin. *M. equinum* lesions are usually less severe and consist of small scaly areas with brittle hairs. Early dermatophyte lesions may resemble papular urticaria.

Dermatophytosis

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Sheep and Goats

- Show lambs
- Circular, alopecic areas with thick scabs on the head, neck, and face
- Widespread lesions under wool
- *T. verrucosum* most common
- Usually self-limiting




Dermatophytosis is common in show lambs, but uncommon in production flocks. The most noticeable lesions are usually circular, alopecic areas with thick scabs on the head and face; however, widespread lesions may be found under the wool when animals are sheared. In healthy lambs, the lesions are usually self-limiting.

[Photo: A sheep with ringworm (or club lamb fungus). Source: Virginia Cooperative Extension]

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Swine

- Wrinkled lesions covered by thin, brown, easily removed scab
- Often asymptomatic in adult swine
- *M. nanum* most common



Pigs develop a wrinkled lesion covered by a thin, brown, easily removed scab, or a spreading ring of inflammation. Dermatophyte infections are often asymptomatic in adult swine.

[Photo: A sow with multiple ringworm lesions. Source: American Association of Swine Veterinarians]

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Rodents, Rabbits

- Rodents
 - Often asymptomatic
 - Alopecia, erythema, scales
- Rabbits
 - Young animals
 - Focal alopecia, erythema, crusts, scabs around eyes, nose, ears, and feet
- *T. mentagrophytes* most common

Most rodents infected with *T. mentagrophytes* are asymptomatic or have few clinical signs. In mice, partial or complete areas of alopecia, erythema, scales, and scabs may be seen, often on the tail. In rats, the lesions are usually found on the back. Guinea pigs usually develop pruritic, ovoid, hairless, raised areas, with crusts or scales; these lesions first appear on the face then spread to the back and limbs. In rabbits, dermatophytosis most often occurs in young, newly weaned animals. Focal alopecia, with erythema, crusts and scabs, is seen around the eyes, nose and ears, with secondary lesions appearing on the feet. The disease is usually self-limiting.

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Birds

- Alopecia
 - Especially head and neck
- Scaling
- Auto-mutilation
- Feather plucking
- *T. gallinae* most common

In birds, there may be alopecia, particularly on the face and neck, scaling, auto-mutilation and feather plucking. Some lesions may be ring-shaped or pruritic.

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<p>Post-Mortem Lesions</p> <ul style="list-style-type: none"> • Post-mortem lesions identical to those of live animals • Restricted to: <ul style="list-style-type: none"> - Hair - Nails - Superficial skin

Post-mortem lesions are identical to those in live animals; dermatophytes are restricted to hair, nails and superficial skin.

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<p>PREVENTION AND CONTROL</p>

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<p>Diagnosis</p> <ul style="list-style-type: none"> • Wood’s lamp examination <ul style="list-style-type: none"> - Detects fluorescence • Potassium hydroxide microscopy <ul style="list-style-type: none"> - Detects hyphae and conidia in skin scrapings or hair • Fungal cultures <ul style="list-style-type: none"> - Required to identify organism • Skin or nail biopsies
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A Wood’s lamp examination can detect fluorescence in some dermatophytes, including some strains of the zoophilic organisms *M. canis* and *M. equinum* and some anthropophilic dermatophytes such as *M. audouinii*. Potassium hydroxide (KOH) microscopy can detect hyphae and conidia in skin scrapings or hair. Fungal cultures are necessary for the identification of the organism. Skin or nail biopsies are also used in humans.

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<p>Treatment</p> <ul style="list-style-type: none"> • Treatment <ul style="list-style-type: none"> - Systemic antifungals - Topical lotions or shampoos • Animals <ul style="list-style-type: none"> - Disease usually self-limiting <ul style="list-style-type: none"> • Treatment speeds recovery, decreases risk of transmission to others - Onychomycosis difficult to cure
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Treatment of dermatophytosis may include topical antifungal creams or shampoos, and/or systemic antifungals. In humans, tinea capitis, tinea barbae and tinea faciei are generally treated with systemic antifungals. Tinea corporis can usually be treated with nonprescription antifungals. Animals often have self-limiting infections that resolve within a few months, but treatment can speed recovery, decrease the spread of lesions on the animal, and decrease the risk of transmission. Onychomycosis can be very difficult to cure; long term treatment or surgical declawing may be necessary.

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Prevention

- Control of animal disease
 - Isolate and treat infected animals, disinfect premises and fomites
 - Culture newly acquired animals
- Wear appropriate PPE
 - Gloves and protective clothing when in contact with infected animals
- Vaccines
 - *M. canis* vaccine for cats

Control of the disease in animals can prevent some cases of dermatophytosis in humans. Infected animals should be treated and the premises and fomites should be disinfected. New animals should be cultured when introduced. Gloves and protective clothing should be used during contact with infected animals. Such contact should be avoided as much as possible. Vaccines are available in some countries for *T. verrucosum* in cattle, *T. equinum* in horses, and *M. canis* in cats (does not eliminate the fungus).

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Disinfection

- Susceptible to:
 - Benzalkonium chloride
 - Household bleach
 - Strong detergents
- Must remove keratin-containing material before disinfection
 - Shed skin, hairs
 - Vacuuming

Dermatophyte spores are susceptible to common disinfectants such as benzalkonium chloride, dilute (1:10) chlorine bleach, or strong detergents. Chlorhexidine is no longer considered to be a good environmental decontaminant for these fungi. The mechanical removal of any material containing keratin, such as shed skin and hairs, facilitates disinfection. Vacuuming is considered to be the best method in many cases.

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Additional Resources

- World Organization for Animal Health (OIE)
 - www.oie.int
- U.S. Department of Agriculture (USDA)
 - www.aphis.usda.gov
- Centers for Disease Control and Prevention (CDC)
 - <http://www.cdc.gov/nczved/divisions/dfbmd/diseases/dermatophytes/>
- Center for Food Security and Public Health
 - www.cfsph.iastate.edu

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