**Dermatomycosis**

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**BASIC TERMS**

- **Dermatomycosis**— infection of the skin caused by dermatophytes
  - Synonymous with Dermatophytosis
- **Dermatophytes**— fungi that causes superficial infections of the hair, skin or nails
- **Tinea**— infections caused by dermatophytes

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**HISTORY**

- The Discovery that a fungus could cause dermatomycoses was probably made by Robert Remark, who observed unusual microscopic structures in favic lesions.
- The real founder of Medical Mycology, based on his discoveries from 1841 to 1844, was the Parisian physician, David Gruby.
  - He described the clinical and microscopic features of the causal agent of favus, and established the contagious nature of the disease.

**HISTORY (cont.)**

- 1890’s-dermatologist Raimond Sabouraud, established the plurality of ringworm fungi and integrated the mycological and clinical aspects.
  - Classified dermatophytes into four genera: Achorion, Epidermophyton, Microsporum, and Trichophyton.
  - Based on clinical aspects combined with cultural and microscopic features.
- Emmons (1934) modernized this taxonomic scheme. He discarded the genus Achorion and redefined the remaining three anamorphic genera.

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**TAXONOMY**

- **Kingdom:** Fungi
- **Phylum:** Ascomycota
- **Order:** Onygenales
- **Family:** Arthrodermataceae
- **Genus:** Microsporum, Trichophyton, Epidermophyton

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**BASIC BIOLOGY**

**Dermatophyte Genera:**

- **Asexual**
  - Microsporum
  - Trichophyton
  - Epidermophyton

- **Sexual**
  - Arthroderma
SPECIES OF DERMATOPHYTES

From: Clinical Mycology (Dismukes)

MICROSPORUM

- Filamentous keratinophilic fungus found in soil, animals, or humans
- Produce certain dermatophytes for each location:
  - Geophilic (Soil)
  - Zoophilic (Animals)
  - Anthropophilic (Humans)
- All Over

MICROSPORUM

Produce both macroconidia, microconidia, septate hyphae and conidiophores

Macroconidia:
- form via filamentous hyphae
- thin OR thick cell wall
  (Varies based on species)
- multicellular

Source: pfc.hku.hk

MICROSPORUM (cont.)

Microconidia:
- Small (unicellular)
- Generally 2-3 micrometers in length
- Pyriform shape
- Smooth
- Thin-walled
- Form via filamentous hyphae

Source: provlab.ab.ca

TRICHOPHYTON

- Filamentous keratinophilic fungus found in soil, animals, or humans
  - Geophilic (Soil)
  - Zoophilic (Animals)
  - Anthropophilic (Humans)
- Endemic to Pacific Islands, Southeast Asia, and Central America

TRICHOPHYTON (cont.)

- Produce both macroconidia, microconidia, conidiophores, septate hyphae and arthroconidia
- Macroconidia (very few)
- Microconidia (very numerous)
- Arthroconidia – Spores produced asexually by the separation of fungal hyphae
EPIDERMOPHYTON

- Filamentous keratinophilic fungus primarily affecting humans (Anthropophilic)
- All over
- Contains only one pathogenic species: 
  - *E. floccosum*

EPIDERMOPHYTON (cont.)

- Produce macroconidia, septate hyphae, arthroconidia, and chlamydospores (on occasion)
- Macroconidia – in singles or clusters
- Microconidia – absent
- Chlamydospores – Large thick-walled resting spore that are spherical and smooth

ARTHRODERMA

- Genus of fungi that contain the sexual species of *Microsporum, Trichophyton, and Epidermophyton*
- Teleomorph of these genera

Source: arthroderma.hki-jena.de

MORPHOLOGY

Anamorphic:
Reproduce asexually via simple sporulation of arthro-, micro-, or macroconidia from conidiogenous cells

Teleomorphic:
Sexual reproduction of fungi in an anamorphic state (Hyphae)

EPIDEMIOLOGY

Geophiles:
- Saprophytes living in soil
- Colonize keratinous substrates (virulence depends on available keratin)
- Prefer a neutral pH
- *M. gypseum-fulvum* (High virulence)
- Found in soil all over

EPIDEMIOLOGY (cont.)

Zoophile:
- Pathogens typically found in animals (no saprophytes)
- Can survive in dormant states on tissue of animal origin
- *M. canis, T. verrucosum, T. mentagrophytes* (most common types and generally cause ringworm)
- Found all over
EPIDEMIOLOGY (cont.)

**Anthropophiles:**
- Pathogens typically affecting humans
- Spread via community life (human contact)
- M. audouinii, M. langeroni, M. rivalieri, M. ferrugineum (most common)
- Found all over, and has a strong connection to Central Africa

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**Knowledge of geographical endemic dermatophytes is relevant.**

- **Geophilic fungi**
  - Usually transmitted from a soil source.
  - Can be secondarily transmitted by animals to humans.
  - Dogs and cats are the principle hosts in Microsporum canis infections.

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**Fomites play an important role in the acquisition of infections.**

- Outbreaks of ringworm in a chronic healthcare facilities and in neonates have been seen to spread from person-to-person and fomites.
- Herd animals usually cattle are principle hosts in rural areas.
- Less common infections can be spread from pigs, horses, mice, hedgehogs, poultry, and monkeys.

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**Anthropophilic fungi**
- Mostly transmitted by direct contact with infected humans; fomites play an important role.
- Person-to-person, clothing, cotton caps, pillows, combs, and towels.
- Tinea pedis can be spread in exogenously in showers, swimming pools, and locker rooms.

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**Trichophyton rubrum is an anthropophilic dermatophyte.**

**DERMATOPHYTE**

Dermatophyte

- Asexual
  - Microsporum
  - Trichophyton
  - Epidermophyton

- Sexual
  - Arthroderma

**Epidemiology:** Geophilic, Zoophilic, Anthropophilic

**PATHOGENESIS**

- Pathogenesis will vary based on the asexual genera of dermatophytes

- All species invade the stratum corneum of the epidermis and the follicular ostium of hairs

- However, capacity in these areas will vary based on nutrition and enzyme production

**PATHOGENESIS (cont.)**

- Proteolytic enzymes are virulent factors that create the power of the pathogen

- Chemically or physically alter their host environment to their ideal conditions

- Nutrition comes from digestion of host proteins

- Virulence will depend on the ability to produce proteolytic enzymes

**PATHOGENESIS (cont.)**

- A host’s response to these infections includes the release of certain enzymes that will degrade proteins and keratin to inhibit growth

- It is difficult to mimic the pathogenesis because it happens *in vivo* but can only be examined *in vitro*

**DIAGNOSIS**

- Direct microscopic examination
  - Most rapid and effective method to detect fungal infection.
  - Specimens submitted—skin scrapings, hair stubs, and nail clippings.
  - Potassium hydroxide—used in preparation for examination.
    - Easier detection of hyphae by digesting debris and disrupting the keratin’s cellular sheets.

- KOH mount of nail material. You can see the dermatophyte hyphae breaking up into spores.

DIAGNOSIS (cont.)

- **Calcofluor White**—whitening agent that binds to chitin and cellulose in fungus cell walls.
  - Fluoresces on excitation by long wave UV rays or short wave visible light.

- **Periodic Acid-Schiff (PAS stain)**
  - Reaction of cell wall polysaccharide with PAS reagents, resulting in fungus developing a red-violet color in the tissue.

DIAGNOSIS (cont.)

- **Culture Media**
  - **Sabouraud glucose agar (SGA)**
    - Contains cycloheximide to inhibit saprobic contaminating molds.
  - **Dermatophyte test medium (DTM)**
    - Contains Gentamicin and Chloramphenicol to inhibit bacteria.
    - Also has phenol red indicator.

DIAGNOSIS (cont.)

- **Identification**
  - Based on its morphology on SGA
  - **Colony Characteristics**
  - **Microscopic Morphology**
  - **In vitro hair perforation test**

DIAGNOSIS (cont.)

- **Positive hair perforation test.**


DIAGNOSIS (cont.)

- **Production of urease or urea hydrolysis**
- **Nutritional requirements**
- **Histopathology**
  - Toxic reaction to epidermis of often the first response to fungus in the stratum corneum.
**DISEASE MANAGEMENT**

- Treatment
  - Triazoles (fluconazole and itraconazole)
  - Allylamines (naftifine and terbinafine)
  - Morpholines (amorolfine)
  - Add these to others such as griseofulvin and topical agents.

**PREVENTION AND CONTROL**

- Depend on area of body, the casual agent, and the source of infection.
- Routine examinations.
- Good hygiene and avoidance of sharing headgear, combs, and hairbrushes.
- Barbershop instruments should be routinely disinfected.

**PREVENTION AND CONTROL**

- Clothing, bedding, towel, etc., should be washed and disinfected before being used by others.
- Avoid contact sports such as wrestling.
- Good foot hygiene and use of antifungal powders.
- Avoid excessive moisture and walking barefoot in pool and shower areas.

**BROAD SPECTRUM OF TINEA**

**TINEA CORPORIS**

- Dermatophytosis of the glabrous skin of the face, trunk and limbs
- Also known as ringworm, tinea circinata and tinea glabrosa
- Prevalent in humans living in warm, humid climates
  - Risk factors include outdoor occupations, close association with animals and contact sports
  - Can be caused by any of the dermatophyte species

- http://www.youtube.com/watch?v=hnCEYgMYit4&feature=related
TINEA CORPORIS (cont.)

- **Clinical Presentations**
  - Vary from noninflammatory, scaly plaques to inflammatory pustules depending on the infecting organism
- **Diagnosis**
  - Microscopic examination
  - Cultures are necessary to determine the particular pathogen
- **Treatment**
  - Topical antymycotic agents
  - Oral antifungal therapy
- **Prevention**
  - Avoid moist, damp environments (locker rooms)
  - Avoid close, physical contact with infected persons

TINEA BARBAE

- Dermatophytosis of the facial beard area
- Also known as Barbers' itch, ringworm of the beard, tinea sycosis, and trichophytosis barbae
- Rarely seen now
- Acquired from animal sources
- Prevalent in rural areas

TINEA BARBAE (cont.)

- **Clinical Presentations**
  - Hair in infected areas is broken, loose, or absent
  - Chin and neck are first to be affected
  - Prominent adenopathy, fever and malaise
- **Diagnosis**
  - Microscopic examination
  - Fungal cultures
- **Treatment**
  - Oral antifungal medications
- **Prevention**
  - Avoid contact with infected animals

TINEA CRURIS

- Dermatophytosis of the upper thighs, inguinal, pubic, perineal and perianal areas
- Also known as eczema marginatum, gym itch, jock itch, ringworm of the groin, tinea inguinalis
- Epidemics occur in crowded living conditions and shared bathing facilities
- Sweating, tight clothing, and wearing wet bathing suits for a long period of time
TINEA CRURIS (cont.)

- Clinical Presentations
  - Itching, inflammation
- Diagnosis
  - KOH testing of scale from the lesion as well as fungal culture
- Treatment
  - Topical antifungal agents
  - Oral antimycotic drugs
- Prevention
  - Avoid moist, warm environments
  - Avoid tight fitting, nonabsorbent or wet clothing

TINEA PEDIS and MANUUM

- Dermatophytosis of the plantar surface of the feet and toe webs, and of the palmar surface of the hands and interdigital spaces, respectively
- Also known as Athlete's foot, ringworm of the feet, ringworm of the hands
- Males are more likely to be infected
- Incidence increases with age

Diagnosis

- Microscopic examination (KOH) with fungal culture

Treatment

- Topical and/or antifungal agents
  - Ciclopirox, Econazole

Prevention

- Footwear in public facilities

TINEA UNGUIUM

- An infection of fingernails or toenails by dermatophyte fungi
- Onychomycosis – broader term, includes nail infections by nondermatophytes
- Prevalence increases with age
- Infective Pathogens include *T. rubrum*, *T. metagrophytes*, *Aspergillus*, and *Fusarium*.
TINEA UNGUIUM (cont.)

- Clinical Presentation
  - DLSO – invades the nail plate at the lateral nail groove
  - WSO - fungal invasion of the superficial nail plate
  - PSO/PWSO – invades the nail plate through the proximal nail fold and spreads distally

TINEA UNGUIUM (cont.)

- Risk Factors
  - Nail trauma, peripheral vascular disease, diabetes mellitus, immunosuppression, hyperhidrosis, and older age
- Diagnosis
  - Direct microscopy and fungal cultures
- Treatment
  - Systemic antifungal agents
    - Griseofulvin, Ketoconazole, Fluconazole, Itraconazole...
- Prevention
  - Wear protective footwear in public showers/hotels, and use of antifungal powders

TINEA UNGUIUM (cont.)

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TINEA CAPITIS

- Dermatophytosis of the scalp hair follicle
- Also known as ringworm of the scalp and microsporosis capitis
- Most common in prepubescent children
- Most common etiologic agent is M. Canis
- Most common etiologic agent in US and Western Europe is T. tonsurans

TINEA UNGUIUM (cont.)

- Clinical Presentation
- Range from dry scaly patches to inflammatory pustules
- Unexpected hair loss or persistent scaling
- Gray patch, black dot, inflammatory and favus
- Diagnosis
  - Wood’s light examination, direct microscope exam and fungal cultures
- Treatment
  - Systemic antifungal therapy – Griseofulvin, Fluconazole...

TINEA CAPITIS (cont.)

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CASE REPORT 1

- Took place in Siena, Italy
- Studied 206 cases of dermatophyte infections of Microsporum gypseum.
- A geophilic fungi present in soil that infects hair and nails

CASE REPORT 1 (cont.)

Methods:
- Scraped the skin of various individuals and soaked in 30% KOH (potassium hydroxide)
- Placed on a Sabouraud dextrose agar and incubated at 30 degrees centigrade

CASE REPORT 1 (cont.)

Results:

Source: Department of Clinical Medicine and Immunological Sciences, Dermatology Section, Siena University, Siena, Italy

CASE REPORT 1 (cont.)

- Of the experimented cases they narrowed down various cases and found the prevalence to be in farmers

CASE REPORT 1 (cont.)

Source: Department of Clinical Medicine and Immunological Sciences, Dermatology Section, Siena University, Siena, Italy

CASE REPORT 1 - CITATION

CASE REPORT 2

- Took place in Port-au-Prince, Haiti
- Studied an anthropophilic dermatophyte as a result of an increase in dermatophytosis of the scalp
- Experimented 45 males and 19 females with a mean age of 6.1 years

CASE REPORT 2 (cont.)

Methods:
- Took hair samples from the scalp and placed them in 10% KOH and then viewed under a microscope
- Incubated at 25 degrees centigrade and monitored for 30 days

CASE REPORT 2 (cont.)

Group:

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Male (%)</th>
<th>Female (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>15 (32)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>5-7</td>
<td>19 (30)</td>
<td>13 (20)</td>
</tr>
<tr>
<td>8-12</td>
<td>10 (16)</td>
<td>4 (6)</td>
</tr>
<tr>
<td>&gt;12</td>
<td>1 (1.3)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>45 (70)</td>
<td>19 (30)</td>
</tr>
</tbody>
</table>

Source: Medical Mycology March 2009, 47, 197-200

CASE REPORT 2 (cont.)

Results:

Table 1: Age-sex repartition of 64 children enrolled in a prospective study on tinea capitis in Port-au-Prince, Haiti.

Table 2: Sex distribution of the dermatophytes species causative agents of tinea capitis in Port-au-Prince, Haiti.

Source: Medical Mycology March 2009, 47, 197-200

CASE REPORT 2 (cont.)

- This study provided information of the typical dermatophytes exhibited in this region of Haiti
- It showed that prevalent pathogens in cats and dogs (zoophiles) were minimal
- This is due to Haitian culture which keeps a distance from cats and dogs

CASE REPORT 2 - CITATION

RESOURCES

- http://www.ucmp.berkeley.edu/fungi/fungimm.html
- http://www.doctorfungus.org
- http://www.springerlink.com/content/81077j3k66m3630m/fulltext.pdf
- \begin{itemize}
  \item Medical Mycology
    \begin{itemize}
      \item Edited by William G. Meiz and Roderick J. Hay
    \end{itemize}
  \item Clinical Mycology
    \begin{itemize}
      \item Edited by Dismukes, Pappas, and Sobel
    \end{itemize}
\end{itemize}

QUESTIONS

1. Which of the following help with the identification of an infection caused by a dermatophyte?
   \begin{itemize}
     \item A. Production of Urease
     \item B. Nutritional Requirements
     \item C. Microscopic Morphology
     \item D. All of the Above
   \end{itemize}

2. This term is used to describe transmittance through soil.
   \begin{itemize}
     \item A. Zoophilic
     \item B. Antrophilic
     \item C. Geophilic
     \item D. Keratinophilic
   \end{itemize}

3. Virulence depends on the ability to produce which enzyme?
   \begin{itemize}
     \item A. Proteolytic Enzymes
     \item B. Regulation Enzymes
     \item C. Pepsin
     \item D. Trypsin
   \end{itemize}

4. Which of these is not a method of prevention?
   \begin{itemize}
     \item A. Avoid moisture
     \item B. Wear tight fitting clothing
     \item C. Wear shoes in public places
     \item D. Avoid contact with infected persons
5. Microscopic examination can be used for all infections except which of the following?
   - A. Tinea Pedis
   - B. Tinea Manuum
   - C. Tinea Unguium
   - D. Tinea Capitis

6. Which of the following is the sexual genera of dermatophytes?
   - A. Microsporum
   - B. Arthroderma
   - C. Trichophyton
   - D. Epidermophyton