# **How the skin prevents infection?**

- **Dry environment:** Limits colonization by certain microorganisms, including Gram-negative bacteria.
- **Renewal of the epidermis:** Regular shedding of keratinocytes prevents overgrowth of potential pathogens.
- **Protective barrier:** The keratinocytes form a waterproof barrier, blocking the entry of infectious agents.
- Skin secretions include **beta defensins**, peptides that destroy microorganisms by disrupting their cell membranes.
- Skin-resident immune cells: Langerhans cells, dermal dendritic cells, macrophages, mast cells, and eosinophils.

#### How the skin prev 6. Sebaceous glands secrete sebum rich in fatty acids and lactic acid creating an acidic habitat the completely prevent colonization by all bacterial

species on the skin. (TRUE) (FALSE)

- Skin pH: Sebaceous glands secrete sebum rich in fatty acids and lactic acid.
  - Fatty acids are effective against most gram-positive bacteria and gram-negative cocci (e.g., Neisseria)
  - Lactic acid lowers skin pH, inhibiting many microorganisms.
- **Sweat glands** produce sweat containing lysozyme and high levels of sodium chloride.

Lysozyme breaks down bacterial cell walls.

• Sodium chloride concentration can inhibit bacterial growth.

# Skin microbiome

- **Resident microorganisms:** Despite a hostile environment, skin is colonized by specific microbes, including Diphtheroids, *Propionibacterium acnes*, *Staphylococcus*, and *Malassezia*.
- Skin normal flora help to prevent pathogen colonization by:

Blocking attachment to the skin surface.

Producing substances that inhibit the growth of other microbes.

• Habitats on skin:

 $\odot$  Most reside in the superficial stratum corneum and upper hair follicles.

 Moist areas (e.g., scalp, axilla, perineum) have higher colonization than drier regions (e.g., arms, legs, chest, back).

## **Skin microbiome**



4. Viruses represent the highest fraction of the skin microbiome regardless of the skin region sampled. (TRUE) (FALSE)

Nature Reviews | Microbiology

icrobiol 16, 143–155 (2018).

#### **Bacteria rather than viruses**

# Skin microbiome

- **Key colonizers:** Predominantly gram-positive bacteria, including coagulase-negative *Staphylococcus*, *Corynebacterium*, and Propionibacterium.
- Staphylococcus epidermidis is the most prevalent skin
  Staphylococcus epidermidis is the most prevalent skin microorganism in the fungal fraction of the skin microbiome. (TRUE) (FALSE)
  - **Bacterial**
- Candida and Malassezia are the main fungi found on the skin.
- Moist area microbes: Gram-negative bacilli such as *Enterobacter*, *Pseudomonas*, *Klebsiella*, *Escherichia coli*, and *Proteus* are typically found in the skin moist regions.
  - 3. Skin infections/infestations can occur as a result of infection by bacteria, viruses, fungi, protozoa, helminths, or ectoparasites. (TRUE) (FALSE)

# **Common bacterial skin infections**

7. The detection of Propionibacterium acnes on the skin is indicative of an underlying disease condition. (TRUE) (FALSE)

It is part of the normal skin microbiota and only contributes to disease under specific conditions, such as blocked sebaceous glands or an altered immune response.

Role of *Propionibacterium acnes*:

Colonizes hair follicles, playing a significant role in development of acne vulgaris.



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# **Parasitic skin infections**

• Arthropods: The most frequent parasites

Includes Sarcoptes scabiei (cause of scabies).

 Pediculosis capitis, pediculosis corporis, and pediculosis pubis are caused by the lice insects *Pediculus humanus* and *Pthirus pubis*.

 Cimex lectularius (bedbug) feeds nocturnally on human blood meal causing skin rash and blisters.

• Protozoa: Common in certain regions

*Leishmania* species transmitted by sand fly, causing leishmaniasis.

• Helminths: Less commonly encountered • Flukes: e.g., Schistosoma spp.

# Maculopapular rashes

Category	Diseases
Childhood Exanthems	Enteroviral rashes
	Erythema infectiosum (Fifth disease/Slapped-cheek syndrome)
	Roseola infantum (Exanthem subitum)
	Scarlet fever
	Rubeola (Measles)
	Rubella
Other Conditions	Infectious mononucleosis
	Secondary syphilis
	Rocky Mountain spotted fever
	Toxic shock syndrome

### **Childhood exanthems**

- Childhood exanthems: rashes that are often accompanied by fever, malaise, and headache.
- These exanthems can be related to the effect of microbial toxins, direct microbial effect on the skin, or an immune/inflammatory reaction in response to an infection.
- Viruses are the primary etiologic agents of exanthems,
  except for scarlet fever (bacterial).
- Childhood exanthems are usually similar, which makes accurate diagnosis difficult. However, some distinct features for each disease can aid to reach the correct diagnosis.



- Prodrome: a high fever (40°C), followed by a sudden decrease in temperature. Early signs also include lethargy and irritability. Patients may also experience seizures and cough.
- Rash: Appears after the fever subsides, presenting as a macular or maculopapular erythematous rash.
- The rash begins on the trunk and moves to the extremities. The lesions do not merge. The rash disappears within 2 days. 10. Exanthema subitum cause a vesicular rash in early childhood. (TRUE)

Maculopapular rash rather than vesicular rash

# **Scarlet Fever**

- The prodrome starts with pharyngitis, fever, and headache.
- 1-2 days after the prodrome, the rash starts on the neck, spreading to the trunk and extremities. The rash is erythematous, sandpaper-like.
- Distinctive features include the intensification of rash in skin folds, forming Pastia lines (also called the Thompson sign). Initially, the tongue appears has a white coating and swollen red papillae (white strawberry tongue).
- The rash is followed by a desquamation phase, where the rash fades 3-4 days after onset, followed by peeling, starting from the face. Tongue peeling occurs 2 days post-rash, resulting in a red, swollen tongue with prominent papillae (strawberry tongue).

# Rubeola (Measles)

- The prodromal phase is characterized by Coryza, Conjunctivitis, nonproductive Cough (the "three Cs"), and fever. This is followed by the pathognomonic Koplik spots that are blue-gray macules on an erythematous base on the buccal mucosa.
- The measles rash starts at the hairline, spreading to the trunk and extremities. The rash is most concentrated above the shoulders, often merging (morbilliform rash).
- The rash lasts 4-6 days, fading from the head down, with full recovery within 7-10 days.
- The disease is highly contagious from four days before to four days after the rash appears.

#### Rubella (German Measles)

- The prodromal symptoms include fever, malaise, headache, coryza, and mild conjunctivitis without cough.
- The rash is maculopapular that emerges 1–5 days post-prodrome, starting from the forehead and face, then spreading to the trunk and extremities. The rash may merge into a scarlatiniform (sandpaper-like) appearance and fades within 3 days, starting from the forehead and face and moving downward.
- Additional signs include Forchheimer spots (petechial lesions on the soft palate) in addition to postauricular and suboccipital lymphadenopathy.
- The disease in contagious from 1 week before the symptoms start and for 5 days after the rash first appears.

# **Enteroviral rashes**

- Typical symptoms: Fever, general discomfort (malaise), and headache.
- The rash may appear with the fever or after the fever has declined.
- The rash appearance is variable depending on the specific enterovirus involved.
- Echoviruses can cause rashes like rubella, measles, or roseola.
- Echovirus 16 specifically leads to a roseola-type rash, referred to as **Boston exanthem**.
  In Australia, Boston exanthem occurs primarily in December. (TRUE) (FALSE)
- Coxsackie A viruses result in pustular stomatitis and extensive vesicular lesions.

# Epidemiology of childhood exanthems

- Exanthems are prevalent worldwide, mostly in children.
- Transmission routes:
- Primarily spread through aerosolized respiratory droplets.
- Virus particles can become airborne from skin contact, leading to infection.

# **Diagnosis of childhood exanthems**

- Usually clinical diagnosis.
- The distribution and the type of rash can be valuable in achieving an accurate diagnosis.
- Serologic tests can also be helpful to confirm the diagnosis
- Scarlet fever can be detected by culturing for S. *pyogenes* or with a rapid strep antigen test.
- S. *pyogenes* produces beta hemolysis on sheep blood agar plates and is sensitive to bacitracin.

#### **Treatment and prevention of childhood exanthems**

#### Supportive care is used in the treatment.

- Mumps-measles-rubella (MMR) vaccine is effective in preventing measles and rubella. Testing pregnant women for the presence antibodies to rubella is important to determine if the fetus is at risk of infection following exposure to a person with rubella.
- Patients with **scarlet fever** are usually treated with **antibiotics**. Treatment within 10 days of the appearance of symptoms can significantly reduce the chances of the patient developing rheumatic fever.



# Infectious Mononucleosis

- Infectious mononucleosis can cause a rash in a certain subset of patients.
- Epstein-Barr virus (EBV) causes this disease.
- Petechiae on the hard and soft palates can be seen in 25–60% of patients.
- A maculopapular rash is widely scattered, and erythematous, and occurs in 10–15% of patients.
- The rash is more common in young children.

# **Secondary Syphilis**

- Syphilis manifests in three stages: primary, secondary, and tertiary.
- The stage with the most prominent skin lesions is secondary syphilis with many maculopapular lesions that cover most of the body.
- Syphilis is caused by *Treponema pallidum*.
- *T. pallidum* is visualized through darkfield microscopy.



Credit: Gado Images Rights Managed

# Secondary Syphilis – Clinical Manifestations

- In neonatal syphilis, the lesions can be vesicular, bullous, or maculopapular.
- Unlike the childhood exanthems and infectious mononucleosis, lesions in secondary syphilis can be seen on the palms and soles.
- The lesions regress without treatment, but relapses of the rash can occur in 20% of untreated patients.



### **RMSF – Skin Manifestations**

- The majority of RMSE patients present with rash 3 days after the bite.
- A unique manifestation of this disease is that the rash begins as erythematous macules on the wrists and

ankles.

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# Toxic shock syndrome (TSS)

- Toxic shock syndrome (TSS) is an uncommon but severe systemic life-threatening disease that follows exposure to a bacterial superantigen produced by certain strains of *S. aureus* and *S. pyogenes*.
- The most common cause of TSS is *S. pyogenes* strains producing either superantigen SPE A or C.
- *S. aureus* also causes TSS. Staphylococcal TSS can occur during menstruation or following a localized staphylococcal infection (non-menstrual TSS). Staphylococcal TSS is caused by the superantigen exotoxin TSS toxin-1 (TSST-1) or enterotoxins.

### **Toxic shock syndrome – Clinical Manifestations**

- Streptococcal TSS is defined as any group A streptococcal infection associated with the early onset of shock and organ failure. A diffuse scarlatina-like erythema is seen in only about 10% of patients with streptococcal TSS.
- Staphylococcal TSS is an acute-onset illness characterized by fever, hypotension, and rash and can lead to multi-organ failure and shock. The rash appears later in the disease and has a sunburn-like appearance. Desquamation frequently is seen in patients who survive. The desquamation is especially prominent on the palms and soles.

# Pityriasis versicolor – Diagnosis

- Diagnosis of pityriasis versicolor is based on the clinical examination of the lesions.
- A Wood lamp (produces a peak wavelength of 365nm) can be used to demonstrate white, pale yellow to orange fluorescence due to pityrialactone by *M. furfur*.
- Skin scrapings clarified with 10% KOH and stained with methylene blue may show round budding yeast cells and short fat hyphae described as "spaghetti and meatballs".



Credit: Arumugakani V et al. https://doi.org/10.18231/j.ijced.2020.063



Credit: DermNet. https://dermnetnz.org/topics/pityriasis-versicolor

### **Erythematous patches/plaques: Cutaneous Candidiasis**

- Candida spp. is a fungal commensal of the skin and can overgrow, causing infections of the skin and mucous membranes.
- Infections of the skin are common in immunocompetent persons and even more common among immunocompromised patients.
- The most common cause of cutaneous candidiasis is *C. albicans*. Others are glabrata, parapsilosis, tropicalis, krusei.



Credit: Science Photo Library Rights Managed

#### Cutaneous Candidiasis – Epidemiology & Pathogenesis

- Immunocompromised patients, diapered infants, and patients who are pregnant, obese, or immobile are at increased risk of developing cutaneous candidiasis.
- C. albicans is normal flora of the skin in up to 50% of the general population.
- Predisposing factors can allow overgrowth of this organism, resulting in clinical manifestations.
- Cutaneous candidiasis infection is usually limited to the stratum corneum.

#### **Erythematous plaques: Tinea (Dermatophytoses)**

- Dermatophytoses are superficial fungal skin infections that can occur on every part of the body. This includes tinea capitis (head), tinea corporis (body), tinea cruris (groin), tinea pedis (foot), tinea manus (hand), tinea barbae (beard), and tinea unguium, or onychomycosis (nail).
- *Microsporum, Trichophyton*, and *Epidermophyton* (collectively called the dermatophytes) are the most common causes of dermatophytoses.
- Tinea lesions start as pruritic erythematous macules that become with scaling or vesicles.
- If the infection involves the scalp, hair loss is common (alopecia).

# Tinea (Dermatophytoses) – Epidemiology

- Dermatophytoses affect about 20–25% of the global population.
- The most common dermatophyte infection is tinea pedis.
- Tinea capitis is common in children.
- Tinea capitis, tinea pedis, and tinea cruris are more common in men than in women.
- Tinea unguium on the fingernails is more common in women; however, the same infection on the toenails is more common in men.

## Tinea (Dermatophytoses) – Epidemiology

- Conditions predisposing to dermatophytoses include moist environments and impaired cell-mediated immunity.
- Dermatophytes are transmitted from human to human (anthropophilic such as *T. tonsurans, E. floccosum*), from animals (zoophilic such as *M. canis*), or from soil (geophilic such as *M. gypseum*).
- Infections from zoophilic and geophilic dermatophytes are more severe than anthropophilic dermatophytoses.



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# Tinea (Dermatophytoses) – Diagnosis

- Diagnosis of dermatophytoses is based on clinical appearance.
- Most lesions do **NOT** fluoresce when examined with a Wood lamp.
- A scraping of the lesions followed by 10% KOH treatment is helpful.
- Scrapings from the lesions are cultured on Sabouraud agar.
- Cultures are incubated at room temperature, with growth observed within 7–14 days.



Credit: JOHN DURHAM / SCIENCE PHOTO LIBRARY. / Universal Images Group Rights Managed / For Education Use Only

# **Erythematous plaques: Erythrasma**

- Erythrasma is a bacterial infection of the skin folds under the arms, in the groin and between the toes that is similar in appearance to tinea cruris and diaper rash.
- Differences in the fluorescence of the lesions following examination with a Wood lamp help in determining if the infection is erythrasma (coral-red fluorescence), tinea or diaper rash (no fluorescence).



RP, Smith MA, Mayeaux EJ, Chumley HS: The Color Atlas re, Second Edition: www.accessmedicine.com McGraw-Hill Companies, Inc. All rights reserved.

Credit: Courtesy of Richard P. Usatine, MD., https://basicmedicalkey.com/erythrasma/

# Erythrasma – Diagnosis

- The **coral-red** fluorescence seen when lesions are examined by Wood lamp is secondary to the production of porphyrin by bacteria.
- Skin scraping reveals grampositive rods.
- The skin scrapings also can be cultured to identify the organism.



Credit: Tanya & Philip. https://escholarship.org/uc/item/9zh116s1



Credit: CDC public health image library. https://phil.cdc.gov/Details.aspx?pid=21834

# **Erythrasma – Treatment and Prevention**

- Erythrasma can be treated with topical antibiotic such as fusidic acid cream and clindamycin solution.
- Extensive infections can be treated with oral erythromycin or tetracycline.
- To prevent recurrences, patients should be encouraged to improve hygiene and keep the area dry.

# **Erythematous plaques: Cellulitis**

- Cellulitis is an acute infection of the dermis and subcutaneous tissues caused by different bacteria.
- S. pyogenes and S. aureus are common causes of cellulitis commonly seen in association with wounds or in burn patients. Streptococci groups B, C, D, and G are less common causes of cellulitis. S. pneumoniae can cause cellulitis in certain groups (DM, SLE, drug users, patients with hematologic disorders).
- Gram-negative bacilli (e.g., *E. coli*, *P. aeruginosa*) cause cellulitis resulting in foot ulcers in DM patients. *P. aeruginosa* cellulitis and osteomyelitis often occur following trauma to the foot. *P. aeruginosa* cellulitis is also common in burn patients.
- Pasteurella multocida cellulitis is associated with dog or cat bites.

# Erythematous plaques: Erysipelas

- Erysipelas is a superficial bacterial infection that extends into the cutaneous lymphatics.
- Most cases are due to streptococci, with *S. pyogenes* present in about two thirds of cases, and group G streptococci in a third of cases.
- The lesions are raised and **well** demarcated.

![](_page_34_Picture_4.jpeg)

Credit: Science Photo Library Rights Managed

# Erythematous plaques: Subcutaneous necrotizing infections

- Subcutaneous necrotizing infections cause extensive destruction of the subcutaneous tissues and fascia, and some also cause extensive necrosis of the muscles.
- Diseases include necrotizing fasciitis, non-clostridial anaerobic cellulitis, clostridial myonecrosis (gas gangrene), Fournier gangrene.
- The etiologic agents include: S. pyogenes (the most common cause of necrotizing fasciitis), S. aureus, anaerobes,
  Enterobacteriaceae, Clostridium perfringens (the common cause of gas gangrene), among other Clostridium spp.

#### Subcutaneous necrotizing infections – Clinical Manifestations

- Subcutaneous edema and necrosis are seen.
- With progression, violaceous discoloration and bullae, crepitus, palpable gas in tissues, and dermal gangrene may develop.
- When male genitalia are involved, the disease is called
  Fournier gangrene.

![](_page_36_Picture_4.jpeg)

## Subcutaneous necrotizing infections – Treatment and Prevention

- Gentamicin combined with clindamycin, or cefoxitin or imipenem alone is appropriate treatment of subcutaneous necrotizing infections pending results of cultures.
- Therapy involves incision and extensive debridement.
- Hyperbaric oxygen therapy is also used.
- Prevention involves proper care of wounds and trauma sites.

ChoiceCorrect answerAttempt answerTrueImage: Strate of the strate o

### **Patches: Tinea nigra**

- Tinea nigra is a superficial infection of the stratum corneum caused by the dematiaceous fungus *Hortaea werneckii*.
- The lesions are dark patches often on the palm.
- Microscopic examination of skin scrapings shows branched, septate hyphae and budding yeast cells with melanized cell walls.
- Tinea nigra will respond to treatment with keratolytic solutions, salicylic acid, or azole antifungal drugs.

![](_page_38_Picture_5.jpeg)

Lee JB, Schwartz Z (2022) Tinea Nigra. New England Journal of Medicine 387 (16):1501-1501. doi:10.1056/NEJMicm2204411

# Nodules: Lyme disease

- Lyme disease is the most common tickborne illness in the US.
- Lyme disease is caused by the spirochete *Borrelia burgdorferi*.
- Within 3–30 days after a patient experiences a tick bite, a red macule will appear at the site.
- The macule expands radially as a nodele with central clearing and swelling (erythema migrans).
- Other manifestations are variable and include a flu-like syndrome consisting of malaise, fatigue, chills, fever, headache, stiff neck, myalgias, and arthralgias.

![](_page_39_Picture_6.jpeg)

# Nodules: Kaposi Sarcoma

- Kaposi sarcoma due to HHV-8 (Kaposi sarcoma herpesvirus) occurs in patients with immunosuppression (e.g., AIDS).
- Kaposi sarcoma is a vascular lesion presenting as a violaceous pink to purple plaque/nodule on the skin or mucocutaneous surfaces.
- Patients with HIV-related Kaposi sarcoma respond well to HAART.

![](_page_40_Picture_4.jpeg)

### Nodules: Merkel cell carcinoma

- Merkel cell carcinoma (MCC) is a rare, very aggressive skin cancer with a high mortality rate and a high tendency of metastatic spread.
- The global incidence of MCC ranges from 0.1 to 1.6 cases per 100,000 people per year.
- MCC is manifested by a rapidly growing, painless, erythematous/violaceous nodule or plaque.
- The acronym AEIOU captures these features: A = asymptomatic, E = expanding rapidly, I = immune suppression, O = older than 50 years of age and U=UV-exposed site.

![](_page_41_Picture_5.jpeg)

# Molluscum contagiosum – Diagnosis, Treatment, and Prevention

- Diagnosis is based on the distinctive central umbilication of the dome-shaped lesions. PCR can also be used.
- Without treatment, molluscum contagiosum lesions will heal within several months or years.
- To prevent autoinoculation or transmission to close contacts, therapy may be beneficial and includes topical (e.g., podophyllin, trichloroacetic acid, cryotherapy with liquid nitrogen).
- In immunocompromised patients, improvement of lesions can be observed following treatment with intravenous and topical ritonavir, cidofovir, zidovudine, or intralesional interferon alpha.
- To prevent spread, contact with infected persons should be avoided

# Smooth papules: Condyloma lata

- Condyloma lata are peri-mucosal skin papules in secondary syphilis.
- The lesions are pink or gray papules that occur at the mucocutaneous junctions and in moist or intertriginous areas of the skin.
- The lesions are infectious.
- Lesions of condyloma lata appear 6–8 weeks after the appearance of the primary chancre.
- The disease is usually acquired by unprotected sexual contact with an infected individual.

#### **Verrucous lesions: Warts**

- Common infection by HPV. Lesions can occur anywhere in the skin and on mucous membranes. Over 100 different types of HPV have been identified as agents of human infection.
- Common warts (verruca vulgaris) are hyperkeratotic papules with a rough irregular surface and range from less than 1 mm to larger than 1 cm. They can occur on any part of the body.
- Lesions are usually caused by HPV-2 and HPV-4 (most common), followed by types 1, 3, 27, 29, and 57.

![](_page_44_Picture_4.jpeg)

Credit: DR HAROUT TANIELIAN / SCIENCE PHOTO LIBRARY / Universal Images Group Rights Managed / For Education Use Only

![](_page_45_Picture_0.jpeg)

# Verrucous lesions: Blastomycosis

- Blastomyces dermatitidis is a dimorphic fungus. Organisms grown at 37°C are in the yeast phase. At room temperature, the organism becomes a mold.
- An infection of the lungs precedes the appearance of the skin lesions in patients diagnosed with blastomycosis, with skin lesions occurring in about 25% of patients.
- A fully developed lesion appears as an **elevated purplish red verrucous patch**.

#### Hair nodules: Piedra

- Black piedra is a nodular infection of the hair shaft caused by Piedraia hortae.
- White piedra, due to infection with *Trichosporon* species, presents as larger, softer, yellowish nodules on the hairs.
- Axillary, pubic, beard, and scalp hair may be infected. Treatment for both types consists of removal of the infected hair and application of a topical antifungal agent. Piedra is endemic in tropical countries.
- Shaving the infected hair is curative.

![](_page_46_Picture_5.jpeg)

![](_page_47_Picture_0.jpeg)

اللهمَّ انتِقَامًا؛ لا بِحجم الأَلَم، بل بقُدرَتك المُطلقَة، اللهم انهم تجبّروا فأرهم جبروتك، اللهم أرنا فيهم مايشفي الصدور، اللهم قد طالت الغُمة واشتدت المحنة وعظُم البلاء ففرِّج يارب عن إخواننا المستضعفين. اللهم أطعم أهل غزة من جوع، وآمنِهم من خوف، واشف جرحاهم، وارحم شهداءهم، واجبر كسرهم، وكن لهم عوناً ونصيراً.

اللهم اغفر لنا تقصيرنا في حقهم، وتقبَّل دعاءنا، ولا تسلِّط عليهم بذنوبنا من لا يخافك ولا يرحمهم.

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