MSS

Microbiology

LEC no.1

Writer: Mujidah rahhal

Corrector: Subhi Nassar

Doctor: Malik Sallam

Classification of skin infections, skin defence, and skin microbiome

Malik Sallam, M.D., Ph.D.
School of Medicine
The University of Jordan

Note : First of all we are going to understand the skin structure, because there are some infections that affect different structures of the skin ☺

Overview of the skin structure and its relation to infections

- Two primary layers:
- **Epidermis:** Outermost layer, featuring a protective **stratum corneum** made of **keratinocytes**.
- **Dermis:** Denser, thicker layer with connective tissue, blood vessels, nerve endings, **sebaceous glands**, and **hair follicles**.

Note : The lowerest layer of the epidermis is the basal layer or stratum basali, which is responsible of generating the layers above it.

Complement in this slide :

Q) What is the most common cause of skin infections? Bacteria .

Note : also fungal skin infections are common .

Note : when talking about skin , hair & nails are included.

Q) In which type of cells HPV virus starts initiating the infection ? Basal layer of epithelial cells.

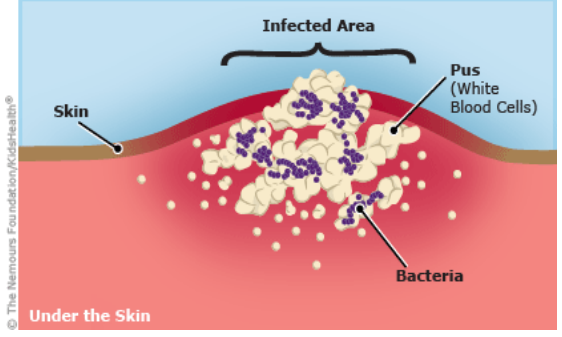
Note : It's important to understand the differences between streptococcus pyogenes vs. Staph aureus

Strep. pyogens

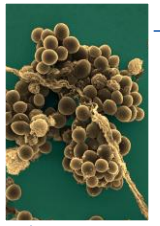
Rapidly spreading

Cause invasive infections as a result of having a group of virulence factors, such as : 1)streptokinase 2) hyaluronidase…

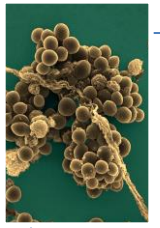
External photo: abscess



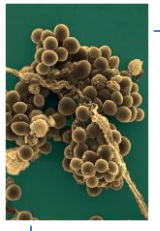
Staph. aureus



Causes localized infections



Not invasive



It has the ability to form abscess in order to avoid the immune system.

Its virulence factor : coagulase enzyme.

How the skin prevents infection?

Note : as the skin is the largest organ & it's exposed to hostile environment, eg : humidity, dryness, microbes, etc. So there is a group of defensive mechanisms.

- **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.

Complement in the next slide

- 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.

Note : the breakage to this role is common when the barrier is destroyed in some cases, eg : burns (burn people become more susceptible to be infected as the protective layer of the skin is removed) , incision; surgical wounds also may lead to surgical site infection .

How the skin prevents infection?

- **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** **(peptidoglycans)**
  - Sodium chloride concentration can inhibit bacterial growth.

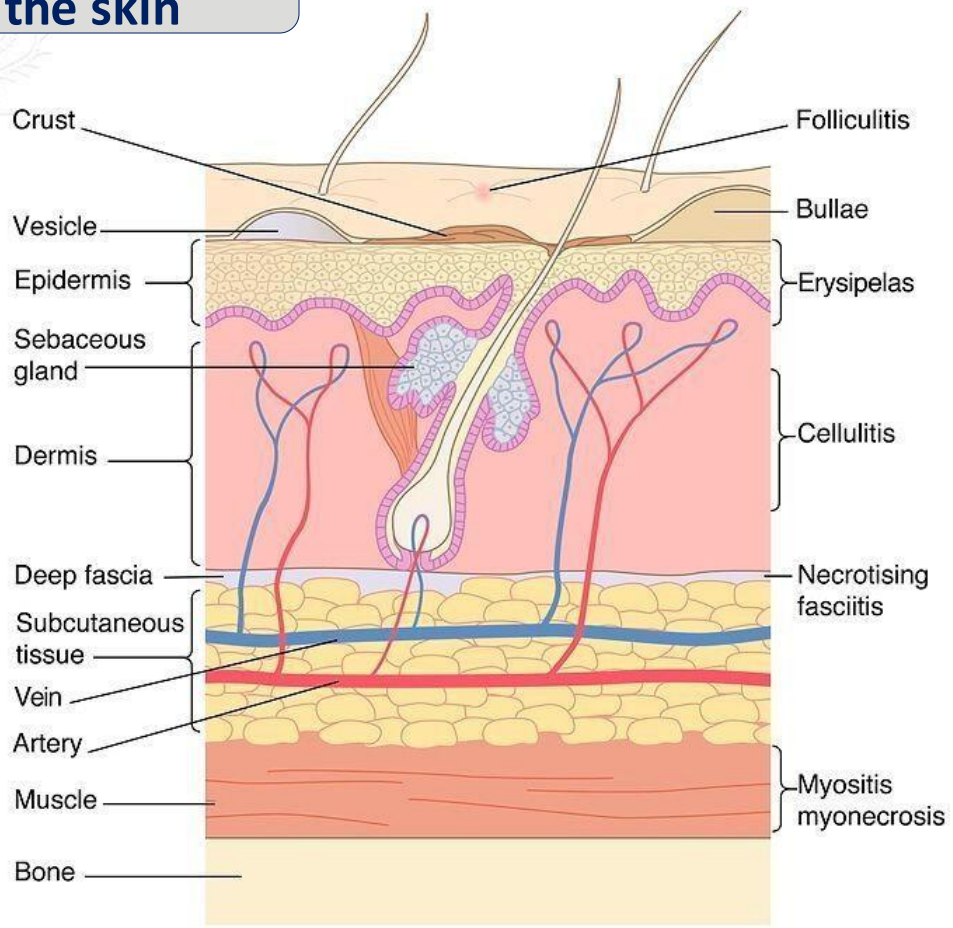
Exception : Staphylococci species can grow in salty media , [NaCl] up to 10%. Enterococci up to 6.5%

Overview of the skin structure and its relation to infections

Infections:

Note : Tinea versicolor , causes hypo or hyper pigmentation of the skin

- **Surface-level:** Dermatophyte infections (e.g., tinea or ringworm) primarily affect the epidermis, especially the stratum corneum.
- **Deeper skin conditions:** Infections like furuncles, carbuncles, and erysipelas can invade the dermis when the protective epidermis is compromised.

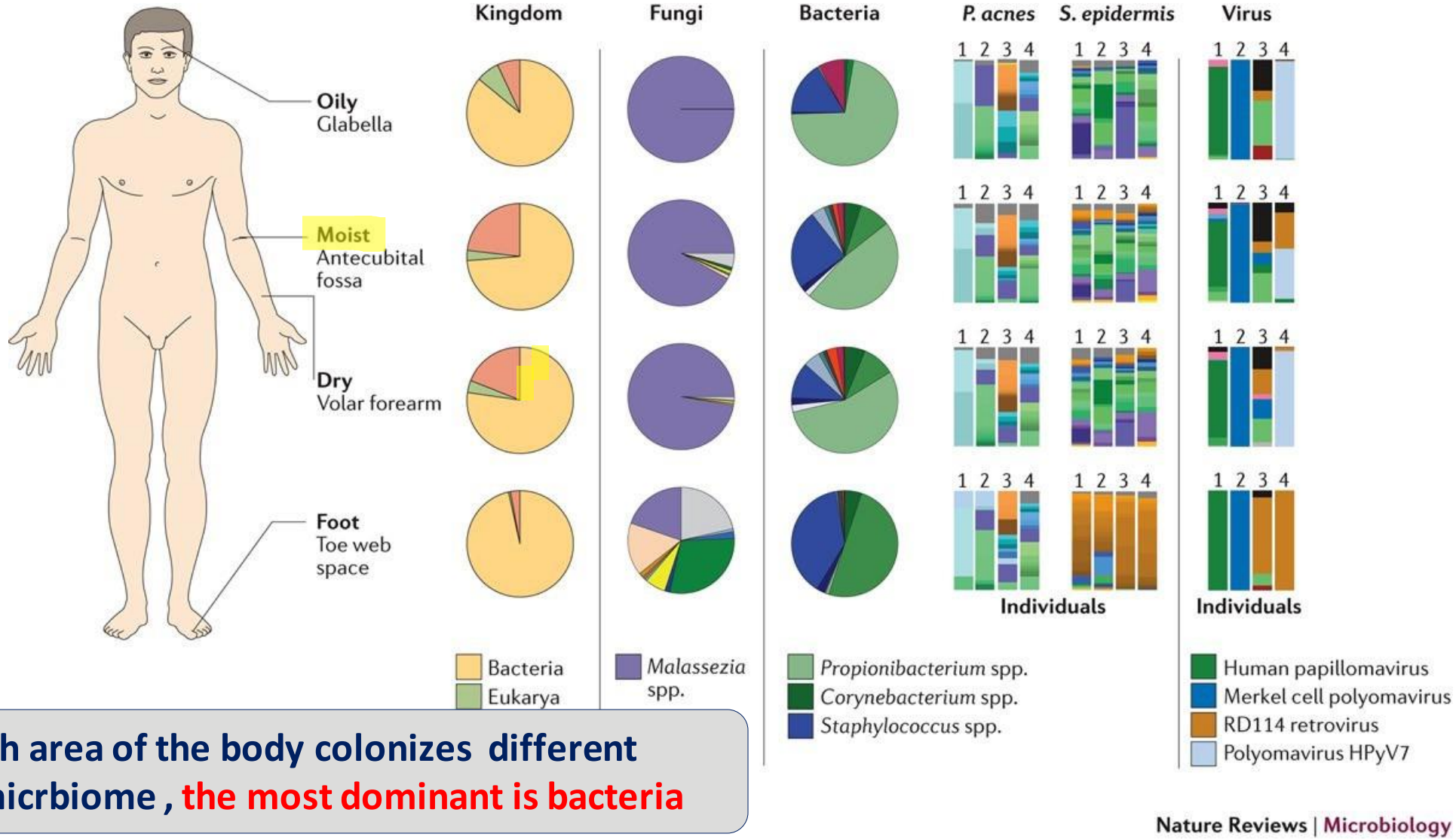


Note : deeper skin infections are Caused by many microbes but the most important are : streptococcus pyogenes (flesh eating bacteria) & staphylococcus aureus. / both are gram positive bacteria.

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:
  - 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



Note : each area of the body colonizes different types of micrbiome , the most dominant is bacteria

Credit: Byrd, A., Belkaid, Y. C Segre, J. The human skin microbiome. Nat Rev Microbiol 16, 143–155 (2018). https://doi.org/10.1038/nrmicro.2017.157

Skin microbiome

- **Key colonizers:** Predominantly gram-positive bacteria, including coagulase-negative *Staphylococcus*, *Corynebacterium*, and Propionibacterium.
- *Staphylococcus epidermidis* is the most prevalent skin microorganism.
- *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.

Additional Question: If someone (immuno-competent) have skin redness and swelling, if we take a sample to the lab, and we see Staph. Epidermidis and Corynbacterium species (NOT diphtheria), and they are resistant to all antibiotics except vancomycin, what you do?

Ans.
These two are Normal microbiota, so they aren't the cause =)

Common bacterial skin infections

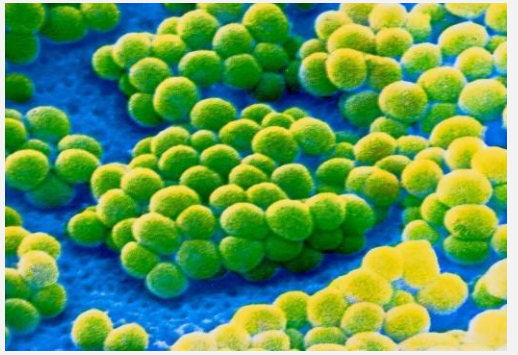
Primary bacterial agents:

- *Staphylococcus aureus*
- *Streptococcus pyogenes*
- *Propionibacterium acnes*

Note: it's a gram positive bacteria , non spore forming , anaerobic (grows deep in the sebaceous glands)

Infections caused by *S. aureus*:

- Bullous impetigo (A)
- Folliculitis (B)
- Furuncles and carbuncles
- Cellulitis and myositis (C)
- Scalded skin syndrome (SSS) (D)
- Toxic shock syndrome (TSS)



External photos

Mechanisms of disease:

Most staphylococcal infections involve invasion and destruction of skin tissue. SSS and TSS are toxin-mediated, resulting from exfoliative or epidermolytic toxins and TSS toxin, respectively.

Common bacterial skin infections

- *Streptococcus pyogenes* infections:
  - Impetigo
  - **Scarlet fever**
  - Erysipelas
  - Necrotizing fasciitis
  - Streptococcal toxic shock syndrome (TSS)
- Mechanisms of *S. pyogenes* infections:
  - Impetigo, erysipelas, and necrotizing fasciitis arise from skin colonization or invasion.
  - Scarlet fever and streptococcal TSS are toxin-induced, linked to streptococcal pyogenic exotoxin (SPE) or erythrogenic toxin.

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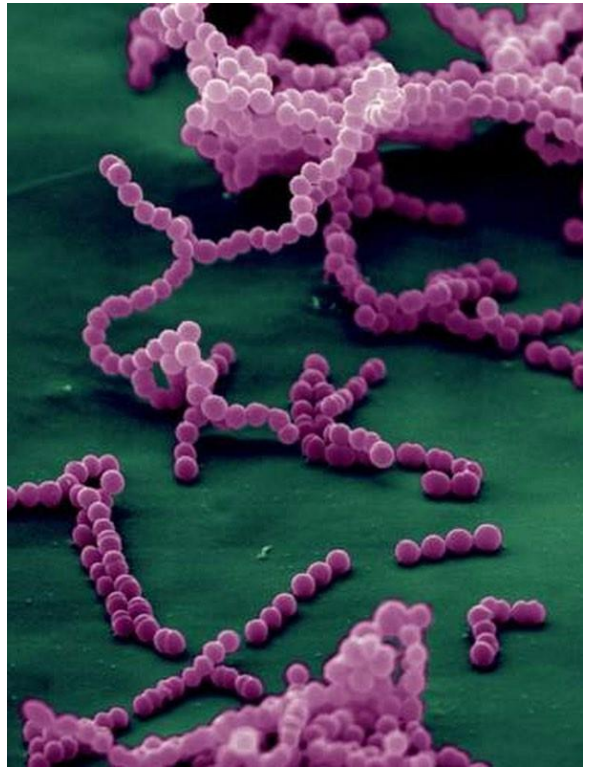

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Exam question: which of the following childhood examples is not caused viral infection?

A) Measles
B) scarlet fever
C) Roseola
D) Fifth disease
E) Rubella

Ans: B

Common bacterial skin infections

Role of *Propionibacterium acnes*:

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

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Viral skin infections

- **Herpes Simplex Virus (HSV):**
- Oral and genital herpes caused by HSV-1 or HSV-2.
- **Human Papillomavirus (HPV):**
- Various strains cause warts, infecting millions annually worldwide.
- **Childhood exanthems:**
- Common viral rash illnesses in children.

Common fungal causes of skin infections

- Main fungal pathogens:
  - *Malassezia furfur*
  - Dermatophytes: *Microsporum*, *Trichophyton*, and *Epidermophyton*
  - *Candida albicans*
  - *Blastomyces dermatitidis*

Example of: Systemic mycoses

- Infection details:
  - *Malassezia furfur* and dermatophytes target the superficial keratinized layers of the epidermis.
  - Dermatophytes can also infect hair and nails.
  - *Candida albicans* primarily causes epidermal infections, leading to conditions like intertrigo, folliculitis, paronychia, and onychomycosis.
  - *Blastomyces dermatitidis*, although less common, can cause cutaneous and systemic infections.

Parasitic skin infections

Scabies caused by itch mite (Sarcoptes scabiei)

- **Arthropods:** The most frequent parasites الجَرَب
  - Includes *Sarcoptes scabiei* (cause of scabies), *Demodex* species (follicle mites), *Tunga penetrans* (sand **flea** causing tungiasis), and larvae causing myiasis (fly larvae infections).
  - Pediculosis capitis, pediculosis corporis, and pediculosis pubis are caused by the lice insects *Pediculus humanus* (*capitis+ corporis*) and *Pthirus pubis*.
  - *Cimex lectularius* (bedbug) feeds nocturnally on human blood meal causing skin rash and blisters.

Pubis can be sexually transmitted

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الدكتور وقف هون بالمحاضرة الوجاهية، ما ذكر اخر نقطتين بالشرح

- **Protozoa:** Common in certain regions
  - *Leishmania* species transmitted by sand **fly**, causing leishmaniasis.
- **Helminths:** Less commonly encountered
  - Flukes: e.g., *Schistosoma* spp.

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Scabies

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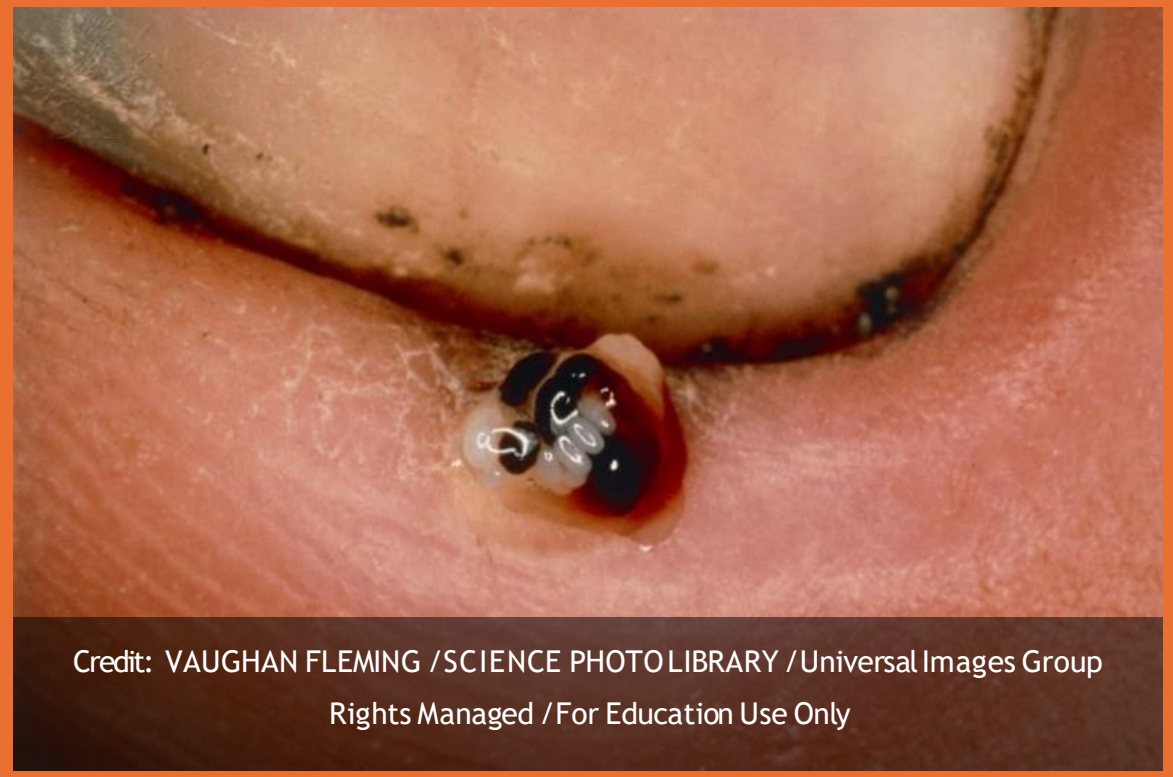
Mite



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Myiasis (larvae)

Cutaneous Leishmaniasis (Aleppo boil)

فرنسا تقرر إغلاق سبع مدارس بسبب انتشار بق الفراش

قررت السلطات الفرنسية إغلاق سبع مدارس تضم 1500 طالب بسبب انتشار بق الفراش. وعقدت الحكومة سلسلة اجتماعات الأسبوع الجاري للبحث في تزايد حالات الإبلاغ عن انتشار هذه الحشرة في وقت تستضيف البلاد كأس العالم للرغبي وتستعد لأولمبياد باريس 2024. ويُعتقد أن عُشر الأسر الفرنسية عانت مشكلة بق الفراش خلال السنوات القليلة الماضية، وعادة ما تكلف عملية التطهير مئات عدة من اليورو.

نشرت في: 07/10/2023 - 11:38 3 دقائق

Credit: France24.com, www.france24.com/ar/فرنسا/20231007-فرنسا-بق-الفشار-إغلاق-سبع-مدارس

This is louse
(plurar is lice)

Credit: WIM VAN EGMOND/VISUALS UNLIMITED, INC. /SCIENCE PHOTO LIBRARY

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Mechanisms of skin infections

Note : this slide will be discussed in the online lecture .

- **Causes of skin lesions:**
  - Direct microbial infection of the skin.
  - Toxins produced by microbes.
  - Inflammatory response to microbial infection.
- **Routes of infection:**
  - Through breaks in the skin outer layer or via hair follicle infections.
  - Common causes of skin breaches include insect or animal bites, human bites, needle sticks, scratches, and burns.
  - Clogged hair follicles are more susceptible to infection.
- **Progression of infections:**
  - Infections can extend into the dermis and, in severe cases, to the subcutaneous fat, fascia, and muscles, leading to conditions such as necrotizing fasciitis, myositis, and gas gangrene.

Skin lesions in clinical practice

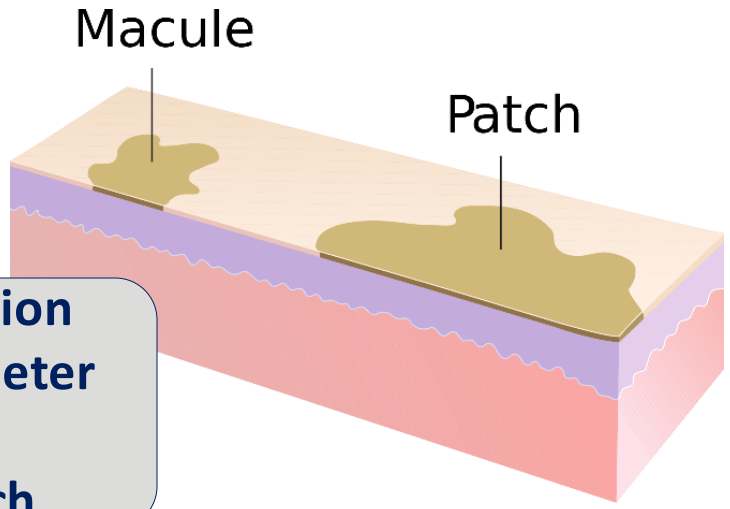
Note : this slide will be discussed in the online lecture .

- **Classification:**
  - Macules: Flat, even with the skin.
  - Ulcers: Sunken, below the skin level.
  - Papules: Raised, above the skin level.
  - Petechiae: Tiny spots from minor bleeding under the skin.
  - Purpura and ecchymosis: Larger blotches or bruises from more extensive bleeding.
- **Infections are not the only causes!**
- E.g., Some lesions develop after exposure to toxins; damage to capillaries, and inflammatory responses

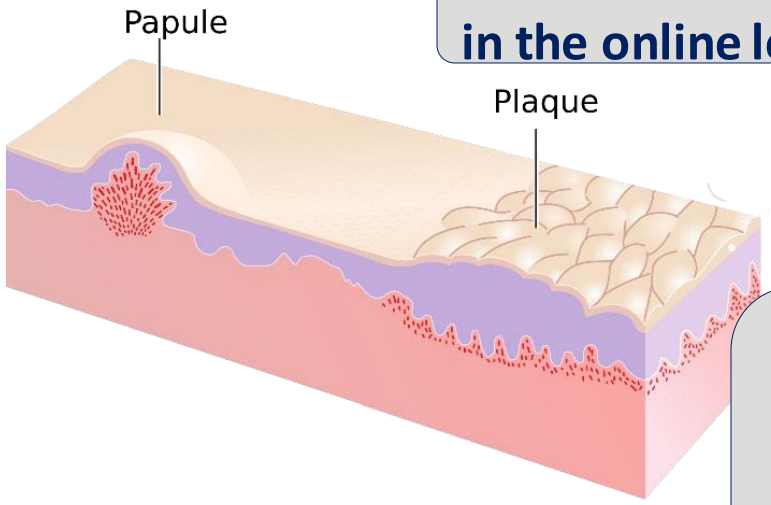
Note : What is the importance to know this classification? Because different pathogens and diseases will manifest in different skin lesions.

Skin lesions in clinical practice

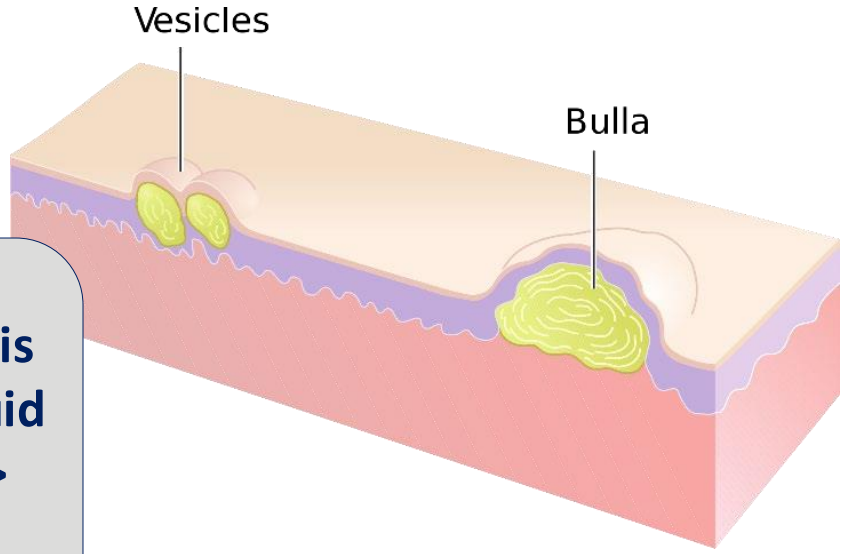
Note : this slide will be discussed in the online lecture .



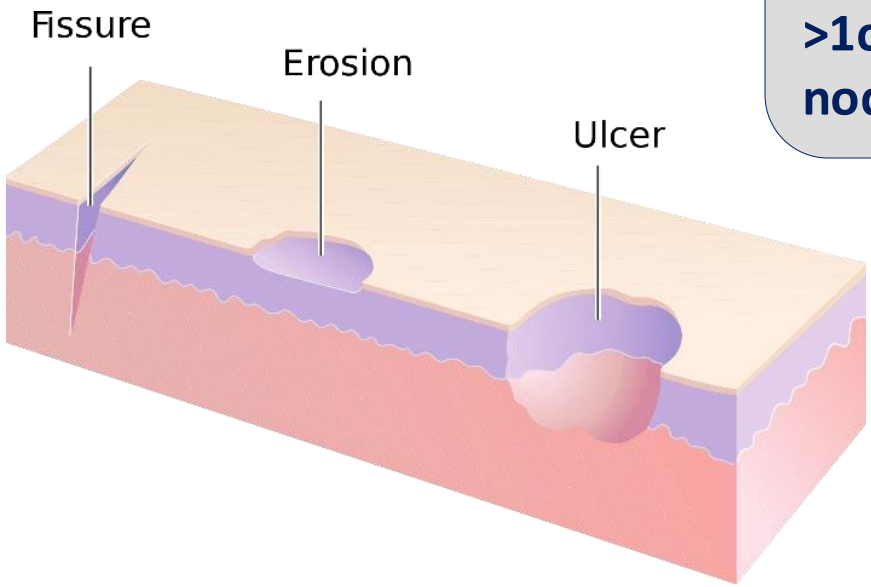
Note :Flat lesion <1cm in diameter —>Macule
>1cm —>Patch



Note : If this lesion is raised and <1cm —>Papule
>1cm —> plaque (or nodules)



Note :If this raised lesion is filled with fluid and <1cm —> Vesicle
>1cm —> Bulla



Thanks for listening!

V2. Added some notes in the last slide that is discussed in the video

V3 —> Additional things added illustrating pictures in page 21/22/23 that are mentioned in the online lecture