Bacterial Infections of the Skin
Lecture 1

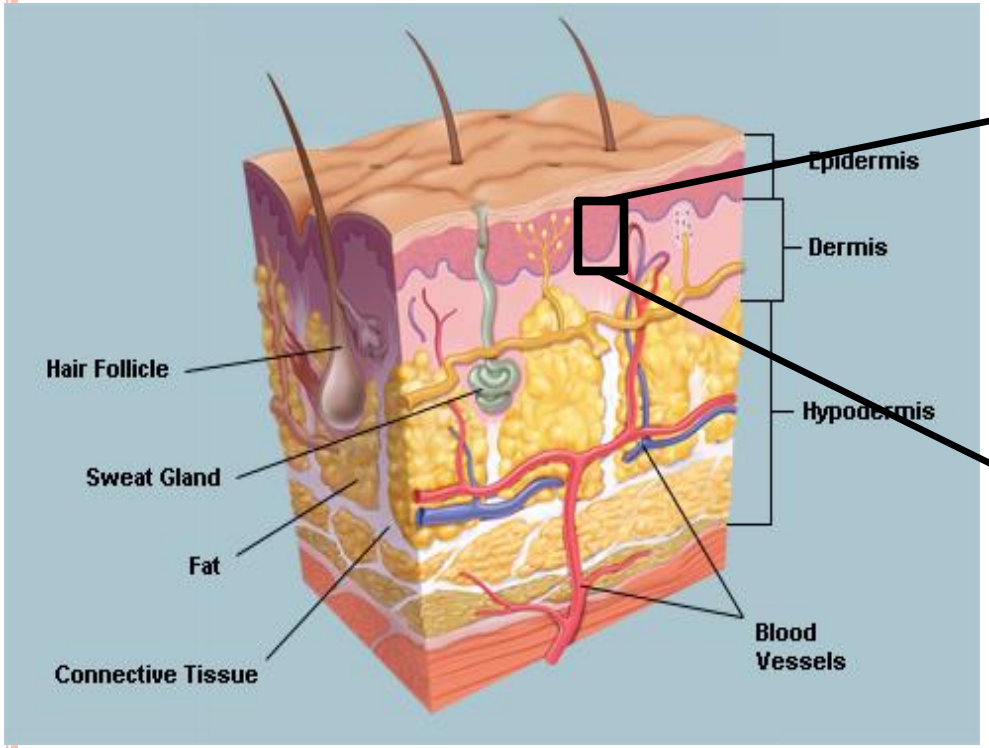
Prof. Eman Albataineh
Department of Microbiology and Pathology
Faculty of Medicine, Mu'tah University

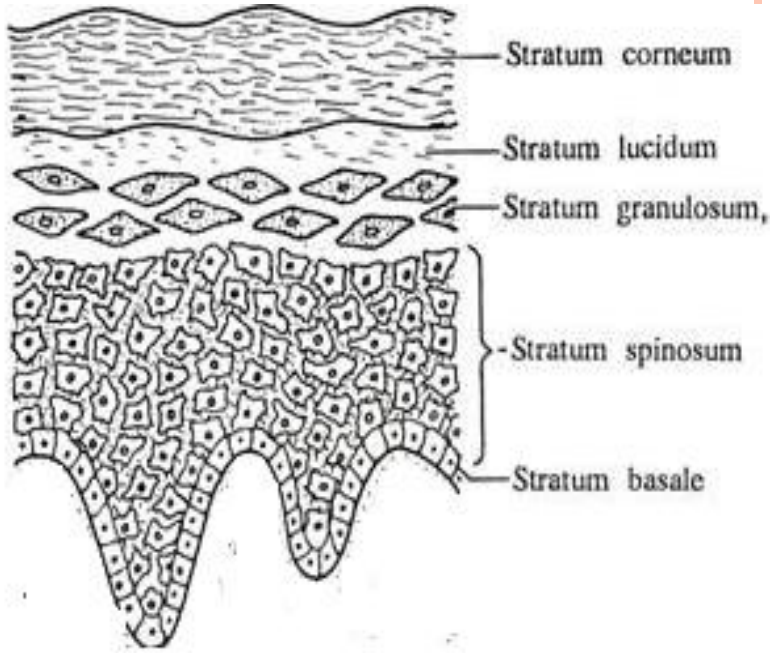
Introduction

Skin Histology

Divided into three layers:

1- Epidermis 2- Dermis 3- Hypodermis (fat layer)





Classification of skin bacteria

Resident	Transient
Propioni bacteria acnes *Staphylococcus epidermidis* Micrococci	**Bacteria** **Frequent:** *Staphylococcus aureus* *Streptococcus pyogenes* **Infrequent:** *Haemophilus influenzae* *Clostridia (gangrene)* *Bacillus anthracis* (anthrax) *Pseudomonas aeruginosa* (hot-tub infections)
	Fungi: ***Candida albicans* (diaper rash, chronic paronychia)**
	Viruses ***Herpes simplex* viruse 1 and 2 (perioral and genital infections) causing Papilloma-warts**

- **Resident: Multiply on the skin and are regularly present**
- **Transient: survive on the skin for only a short period without multiplication & disappear within a short time**

Staphylococci

General characteristics

- **Common inhabitant of the skin and mucous membranes (why?)**

  Because they can withstand high salt, extremes in pH and temperatures

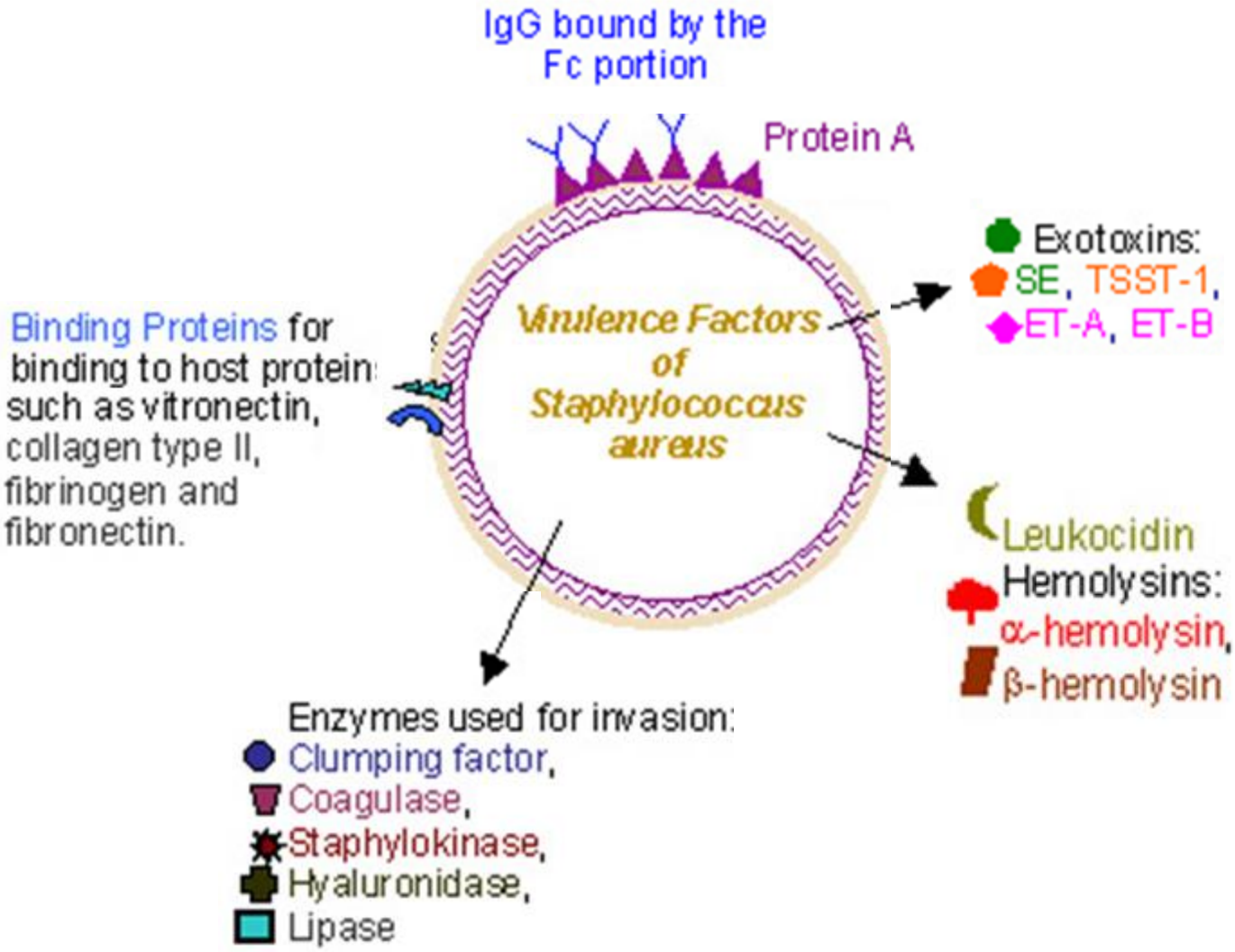
- **The most common cause of the pyodermal infections (pus producing lesions)**

- **Facultative anaerobe**

- **31 species**

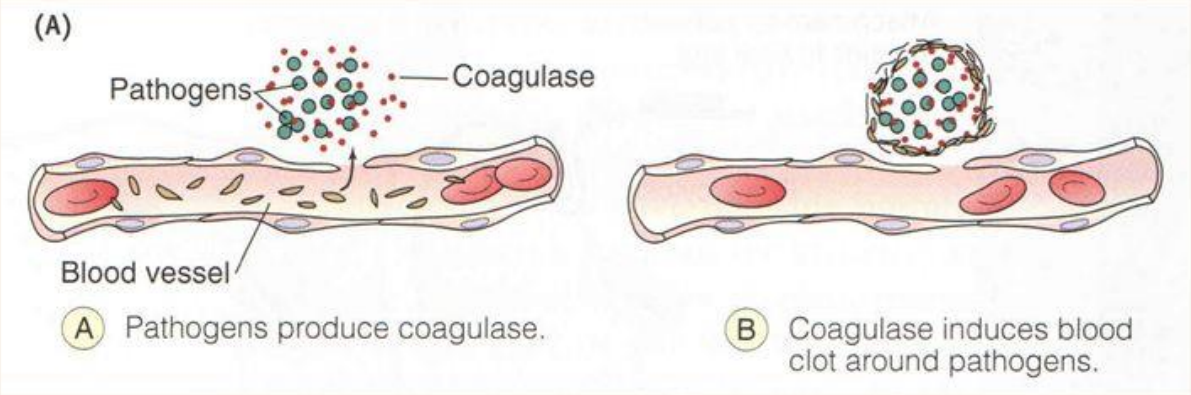
Staphylococcus aureus

Virulence factors



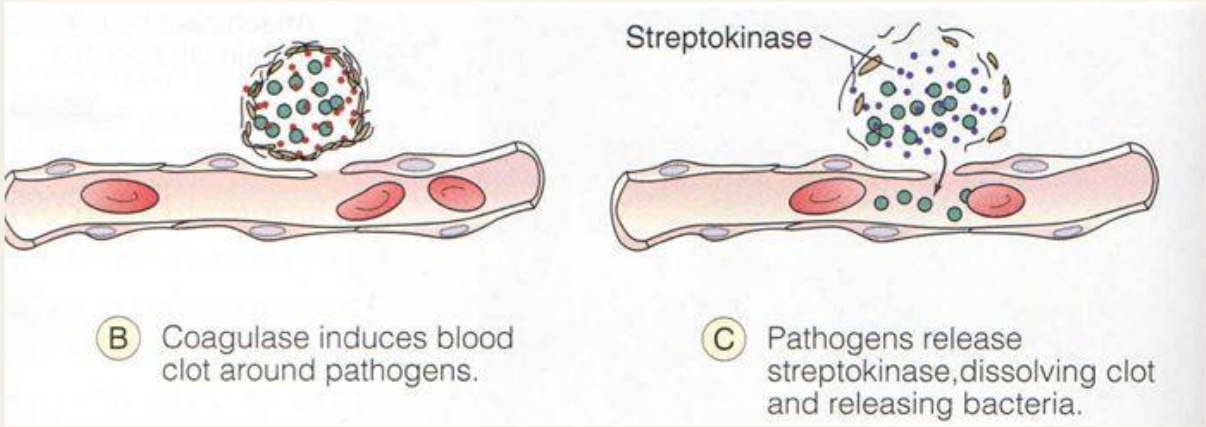
Coagulase

- Coagulase catalyses the formation of blood clots from Fibrinogen proteins in the human blood.
- Blood clots protect bacteria from phagocytosis by WBC's and other host defenses.
- Example:
  - *Staphylococcus aureus*



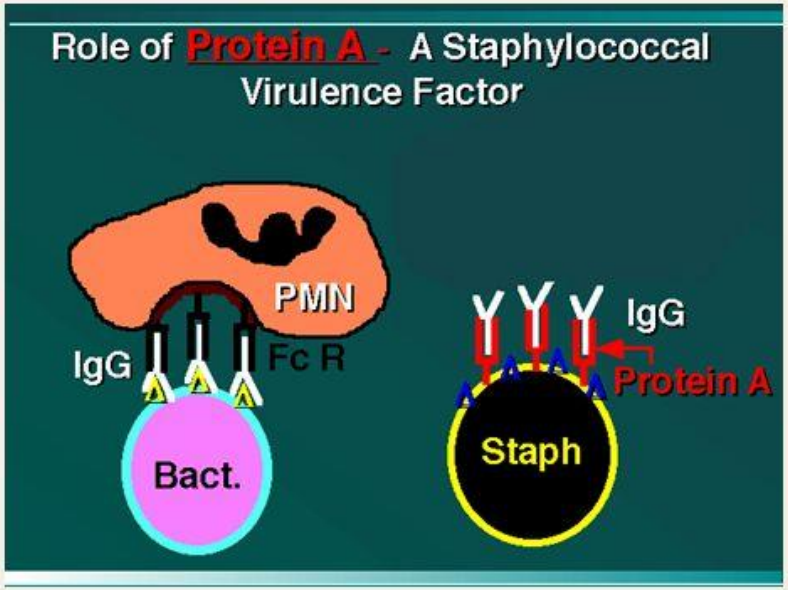
Kinase

- Kinases have the ability to dissolve blood clots used as a defense by the body to restrict and isolate an infected area.
- Kinases help bacteria to spread and cause bacteremia
- Examples:
  - Streptokinase - *Streptococcus sp*
  - Staphylokinase - *Staphylococcus aureus*



Bacterial cloaking

- *S. aureus* produces protein A and *S. pyogenes* produces Protein G which bind the Fc portion of IgG
- Binding of IgG to the bacterial cell surface provides protection against phagocytosis.



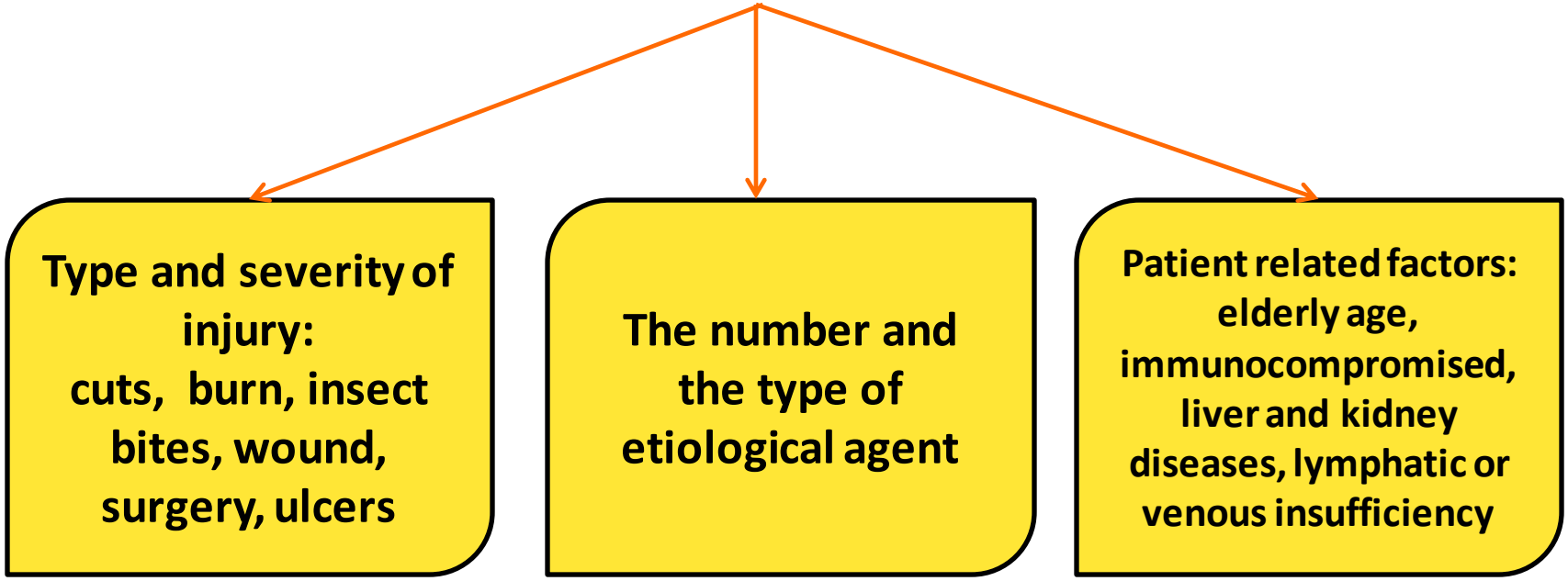
Hemolysins

- Hemolysins combine with the membranes of red blood cells, causing it to lyse.
- Lysing of red blood cells provide pathogens with the iron from hemoglobin, which is required for many metabolic processes.
- α, β, and γ hemolyses
- Example:
  - *Streptococcus sp*
  - *Staphylococcus aureus*

Staphylococcus aureus

Severity of skin infections

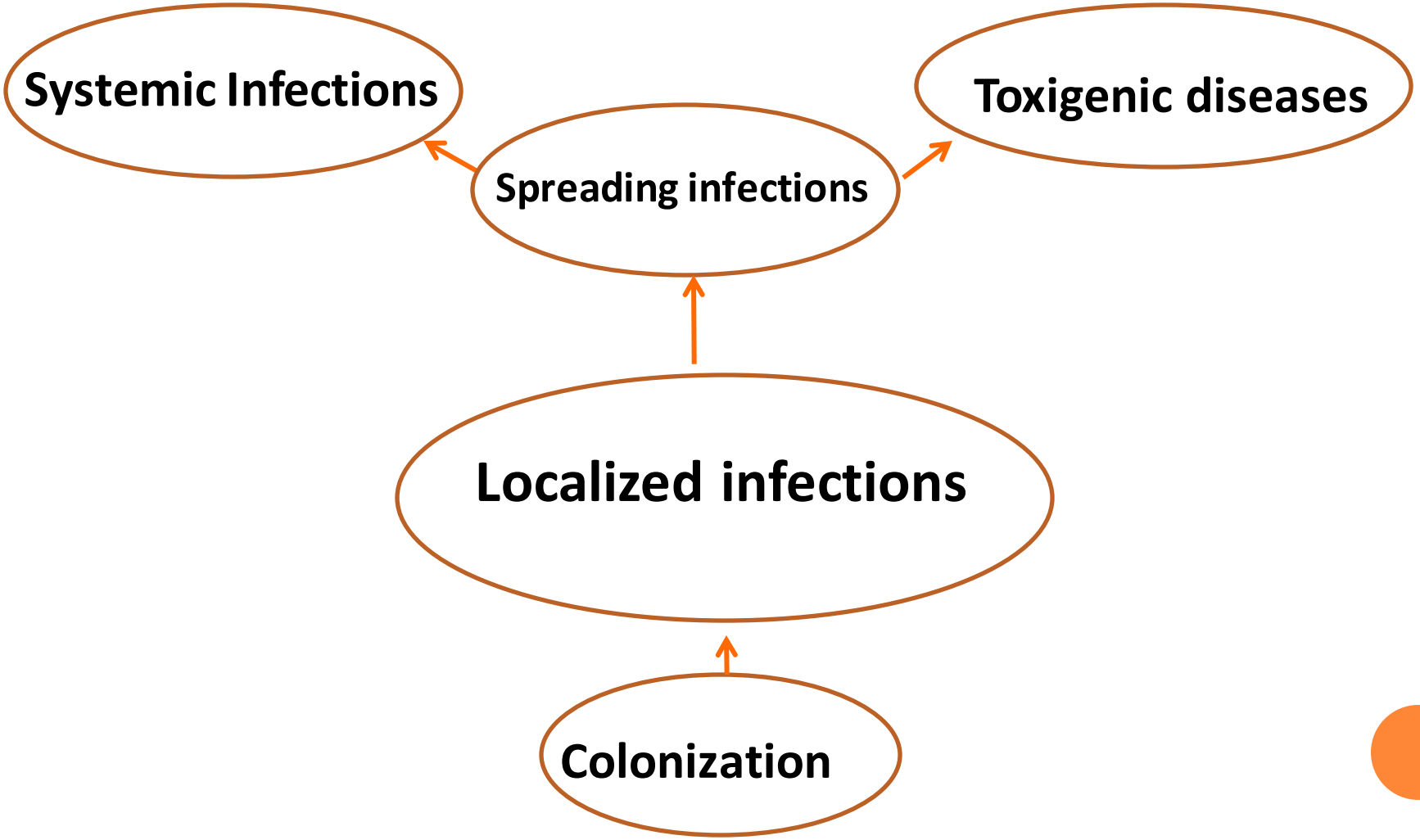
The severity of skin infection is determined by the interaction between different factors



$$\text{Severity of infection} = \frac{\text{Number and type of organism} + \text{Virulence}}{\text{Host resistance}}$$

Staphylococcus aureus

Levels of skin infections

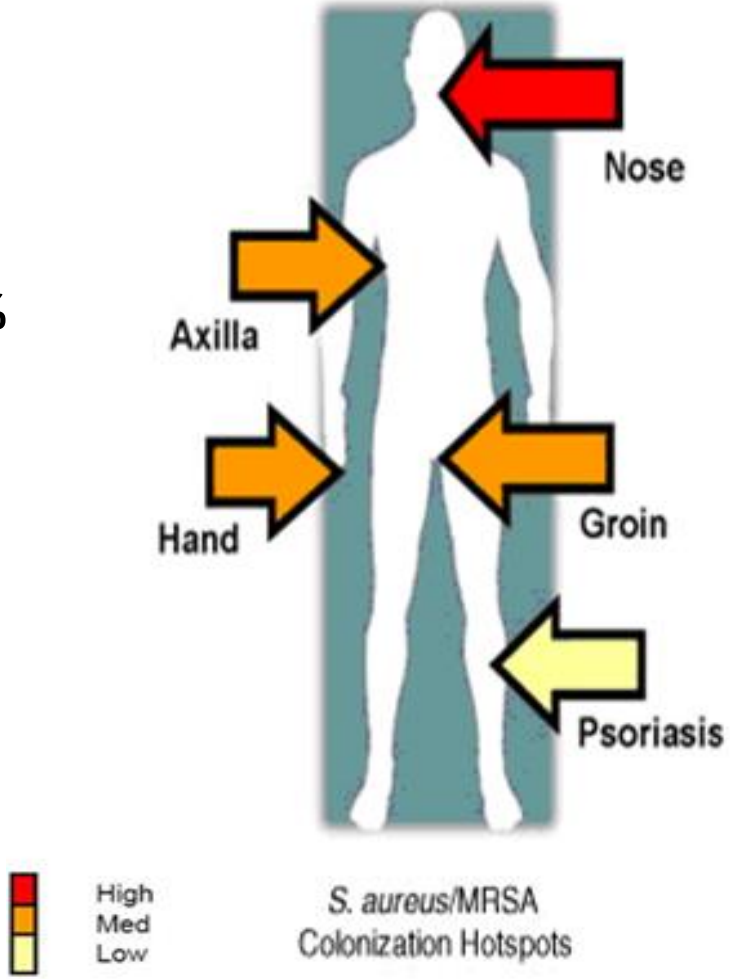


Staphylococcus aureus

Levels of skin infections

Colonization

- **Asymptomatic**
- **The anterior nares and throat of normal healthy adults are colonized (more than 30%**
- **Adhesins involved in colonization**
- **This can result in spread of the infection to others (outbreaks)**



Staphylococcus aureus

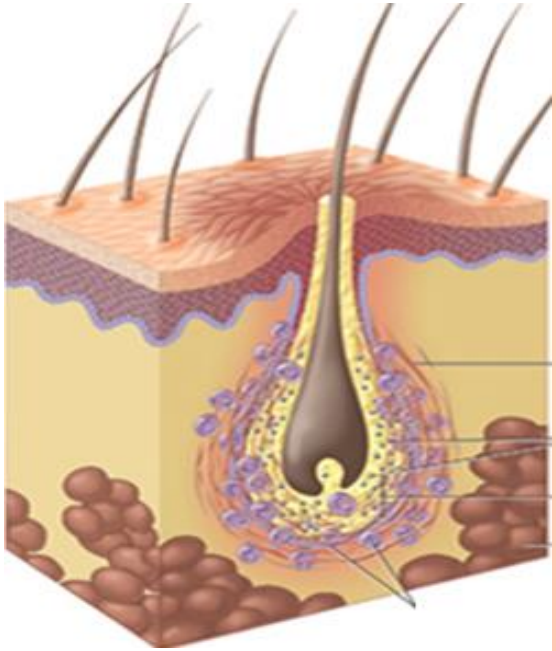
Levels of skin infections

Localized infections (Abscess formation):

- Folliculitis
- Carbuncles
- furuncles

Q: Why do *S. aureus* infections in most cases are localized?

- Coagulase: an enzyme which produces fibrin deposition around the lesions of infection (walling off).
- The fibrin formed around bacteria which is important to stop the action of immune system as phagocytosis.



Staphylococcus aureus

Levels of skin infections

Localized infections

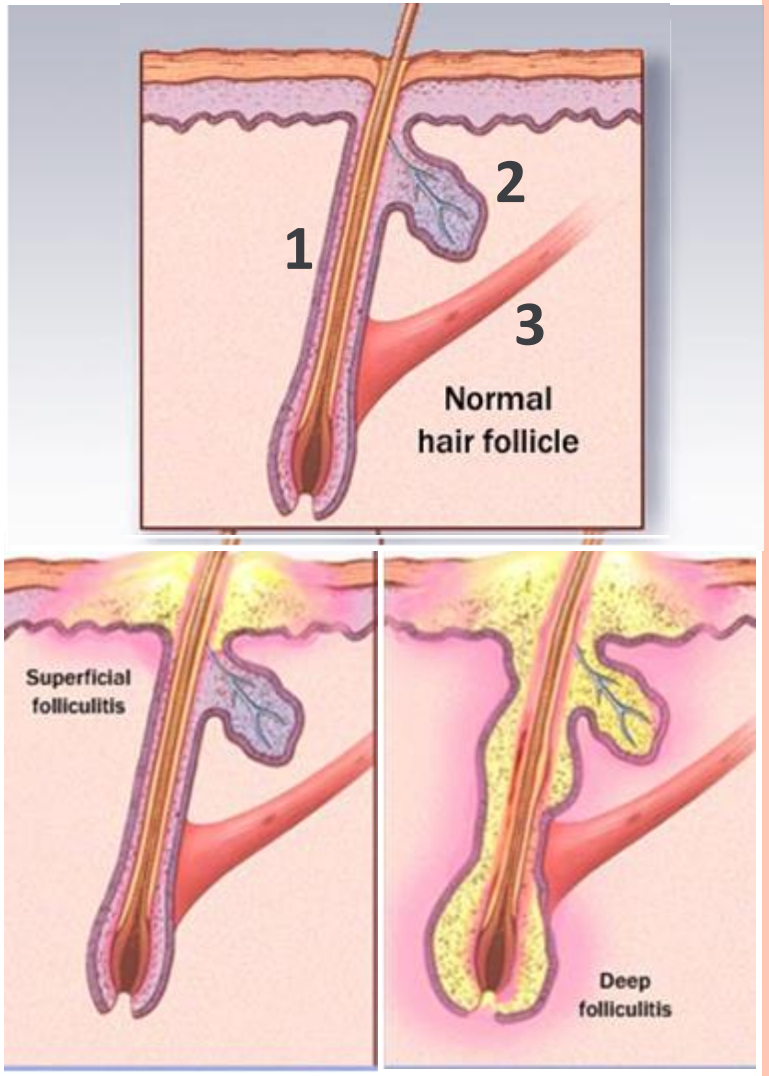
A- Folliculitis

- Superficial or deep infection in the hair follicle
- On the face , neck, axillae, and buttoks
- Causative agents:

✓ *Staphylococcus aureus*

✓Occasionally *Pseudomonas aeruginosa* (hot-tub folliculitis from pool)

✓*Candida albicans* (immunocompromised patients)



Staphylococcus aureus

Levels of skin infections

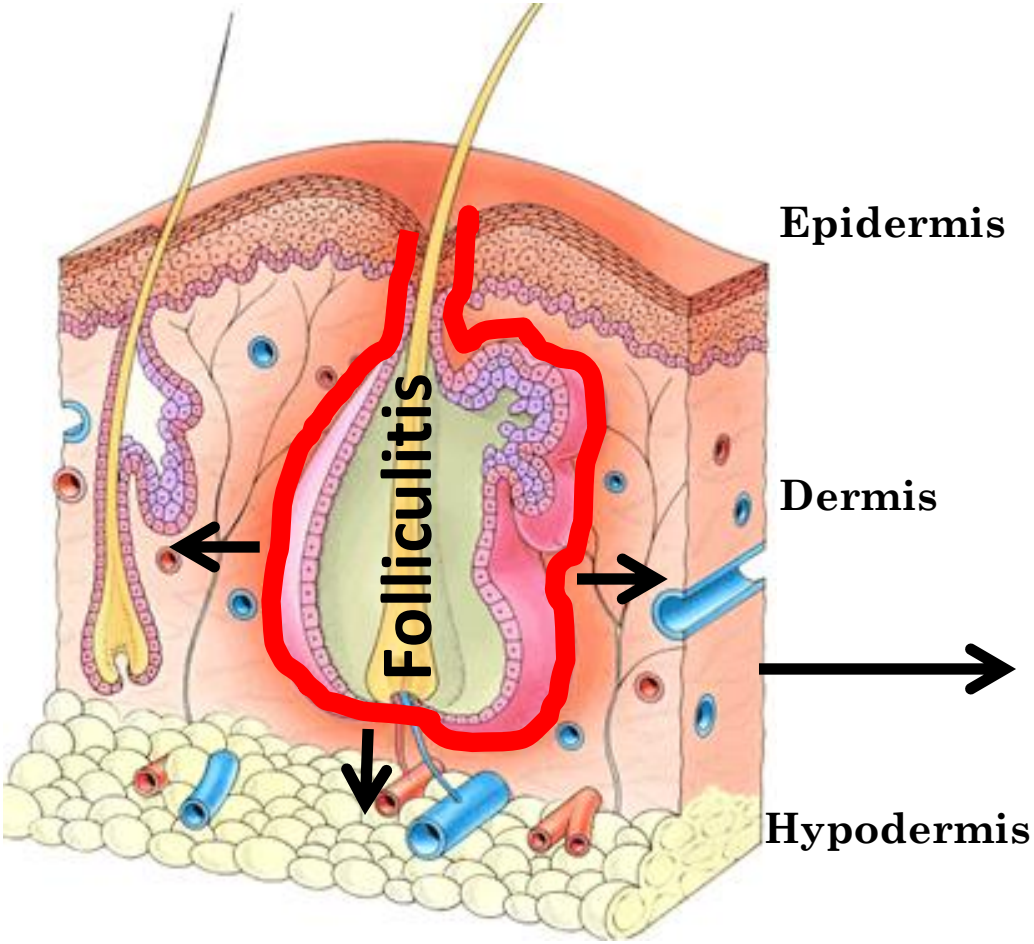
Localized infections

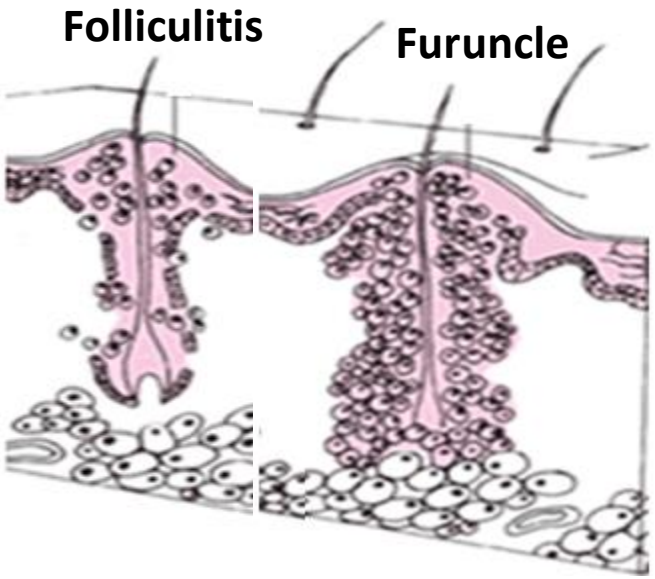
A- Folliculitis

- **Range from tiny white-topped pustules to large, yellow pus-filled lesions**
- **Self-limiting**
- **Rarely, Furuncles, carbuncles, or cellulitis may develop**

Staphylococcus aureus

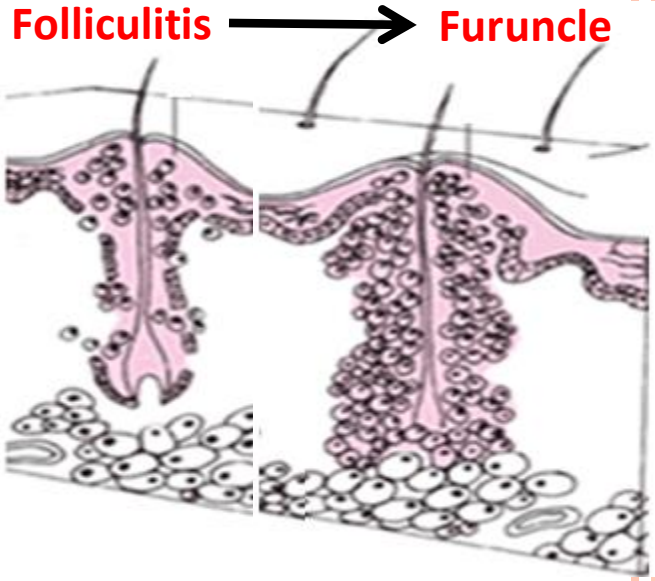
Levels of skin infections





Staphylococcus aureus

Levels of skin infections



Localized infections

B- Furuncle:

- Furunculus: a boil
- Is a tender, soft, swelling filled with pus, often surrounded by an area of colored from pink to deep red.
- Uncontrolled folliculitis .
- If folliculitis isn't stopped quickly, a deep pocket of pus is formed.
- Furuncle contains only one draining point
- It may develop also in a sebaceous or sweat gland

Staphylococcus aureus

Levels of skin infections

Localized infections

B- Furuncle

- **Risk Factors**: that predispose individuals to developing an abscess include:
  - Diabetes.
  - Obesity.
  - Intravenous drug abuse.
  - Weakened immune system due to underlying illness or medication.

Staphylococcus aureus

Levels of skin infections

Localized infections

B- Furuncle

Treatment

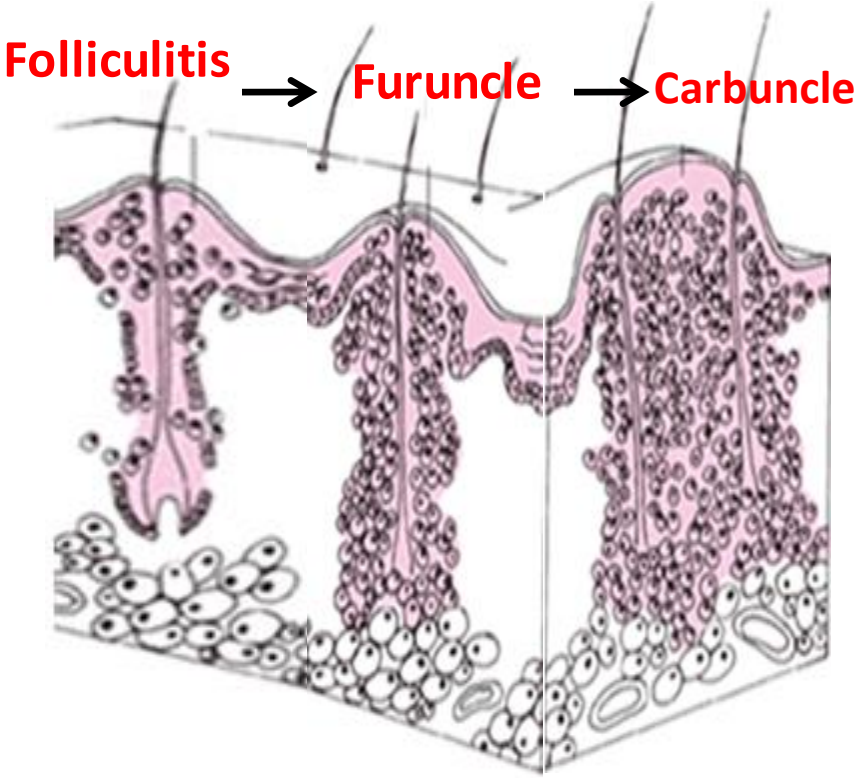
- boils can rupture and go away on their own in generally healthy people
- Large, multiple or frequent boils need antibiotic treatment
- Applying a warm compress or soaking the area in warm water every few hours
- Incision and drainage (I & D)

Complications

- Causing spreading skin infection.
- Releasing of toxins.
- Bacteremia.

Staphylococcus aureus

Levels of skin infections



Carbuncle

Staphylococcus aureus

Levels of skin infections

Localized infections

C- Carbuncles

- A cluster of boils that are connected to each other under the skin
- **Carbunculus: red gem, little coal**
- Pus discharge from multiple openings
- The locations are similar to furuncles
- Leave a scar when it heals. Boils do not usually leave scars.

- **Complications:**

- Carbuncles can progress to cellulitis, and septicemia.
- Brain or spinal abscess

- **Treatment**
  - Avoid squeezing or irritating a carbuncle
  - Warm compresses (20 minutes several times per day)
  - Antibiotics

Staphylococcus aureus

Levels of skin infections

Carbuncles (red gem)

Carbuncles (little coal)

Staphylococcus aureus

Levels of skin infections

Localized infections

- Folliculitis (micro-abscess)
- furuncle (common boil)
- A Carbuncle (A cluster of furuncles)

Staphylococcus aureus

Levels of skin infections

Localized infections (Abscess formation):

- Folliculitis
- Carbuncles
- furuncles

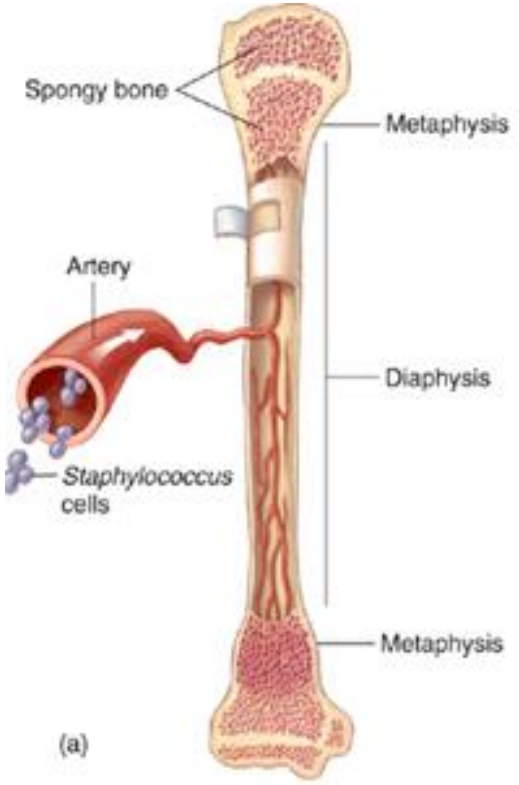
Spreading infections:

Systemic infections (Deep Lesions)

- Osteomyelitis
- Septic arthritis

Staphylococcus aureus

Levels of skin infections



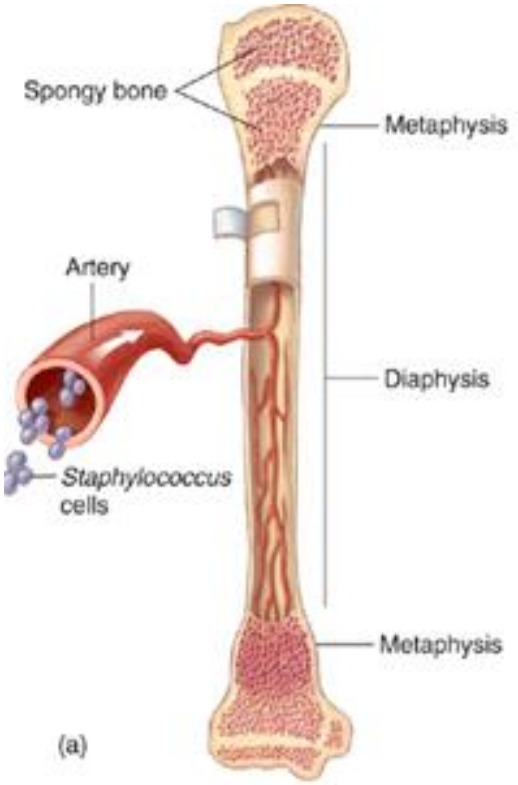
Systemic infections

Septic arthritis

- Septic means infectious
- Purulent infection of joint spaces which produces arthritis
- *S. aureus, Streptococcus* spp., Gram-negative bacilli
- Treated with antibiotics and drainage of the infected joint fluid

Staphylococcus aureus

Levels of skin infections



Systemic infections

Bone infections (Osteomyelitis):

Osteomyelitis

It is inflammation of the bone and its marrow.

Aetiology

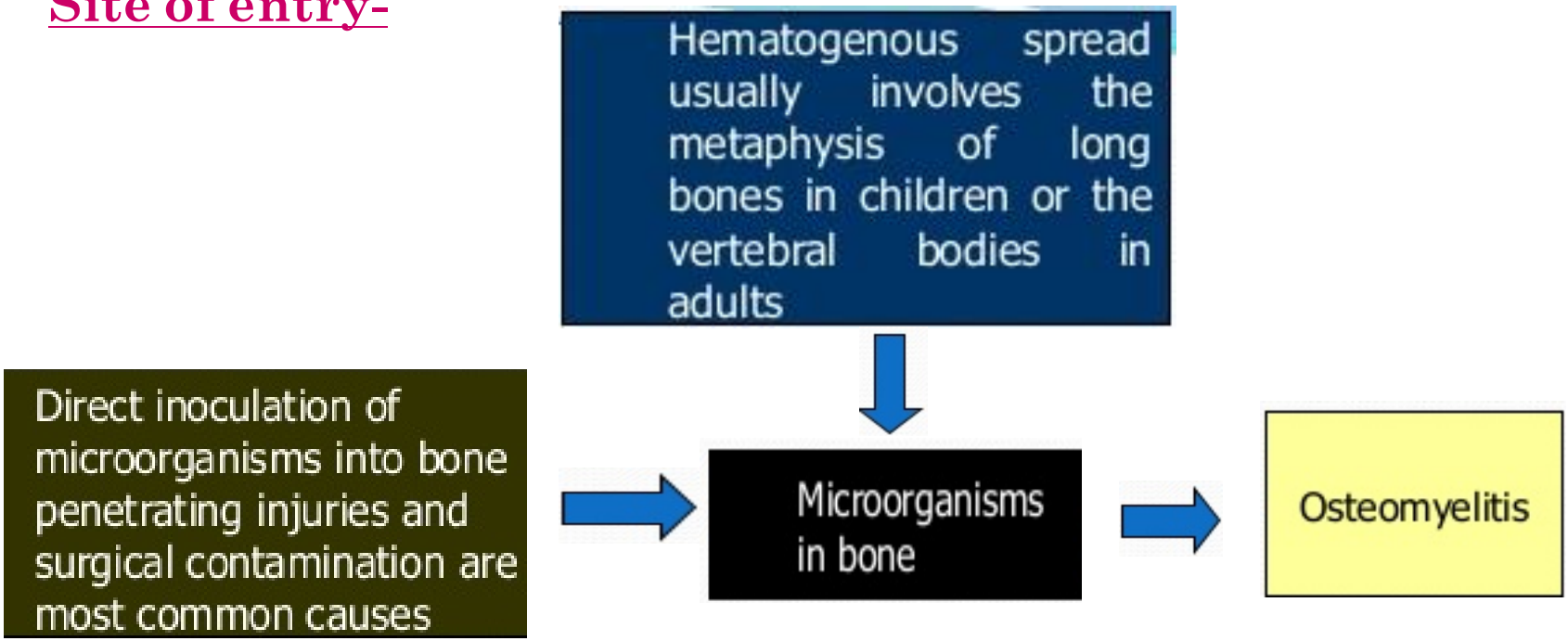
- Bacteria, viruses and fungi can all infect bone, soft tissues and joints. Generally, bacterial infections are more destructive and move rapid.
  - Most commonly – staph aureus, streptococci pyogens, S. pneumoniae, Pseudomonas, Proteus.
  - Under 4 years of age, - H. influenza.
- Fungi tend to produce slow and chronic infections.
- Tuberculosis and brucellosis range from aggressive to reparative.

Staphylococcus aureus

Levels of skin infections

Bone infections (Osteomyelitis):

Site of entry-



Staphylococcus aureus

Levels of skin infections

Systemic infections

Bone infections (Osteomyelitis):

Clinical Features

Sub acute	- Fever/ mild swelling
Early Acute	• Febrile illness • Limping to walk • Avoidance of using the extremity
Late Acute	• Swelling • pain
Chronic	purulent drainage

Staphylococcus aureus

Levels of skin infections

Systemic infections

Bone infections (Osteomyelitis):

Lab Findings:

- Aspirate pus or fluid, a smear is examined for cells and organisms(to identify a type of infection).
- WBC counts are elevated with increased PMN leukocyte count.
- C-reactive proteins – level is elevated
- ESR usually elevate up to 90%.
- Blood culture results are positive in patients with haematogenous osteomyelitis.

- Radiological finding

Staphylococcus aureus

Levels of skin infections

Systemic infections

Bone infections (Osteomyelitis):

Treatment

1. General treatment: nutritional therapy or general supportive treatment by intaking enough caloric, protein, vitamin etc.
2. Antibiotic therapy (flucloxacillin + fusidic acid) for 6weeks).
3. Surgical treatment.
4. I&D
5. Immobilization
6. Splintage of affected part

Staphylococcus aureus

Levels of skin infections

Toxigenic disease

1- Staphylococcal scalded skin syndrome (SSSS)

- Scalding (from the Latin word calidus, meaning **hot**).
- In Infants called Ritter's disease, Leyll's syndrome in older children.
- The disease is most common in neonates and children less than 5 years of age.
- Occasionally occurs in adults, particularly those who are immunocompromised.
- About 5% of *S. aureus* strains produce exfoliatins.
- Most eventually recover.
- **Transmission**:

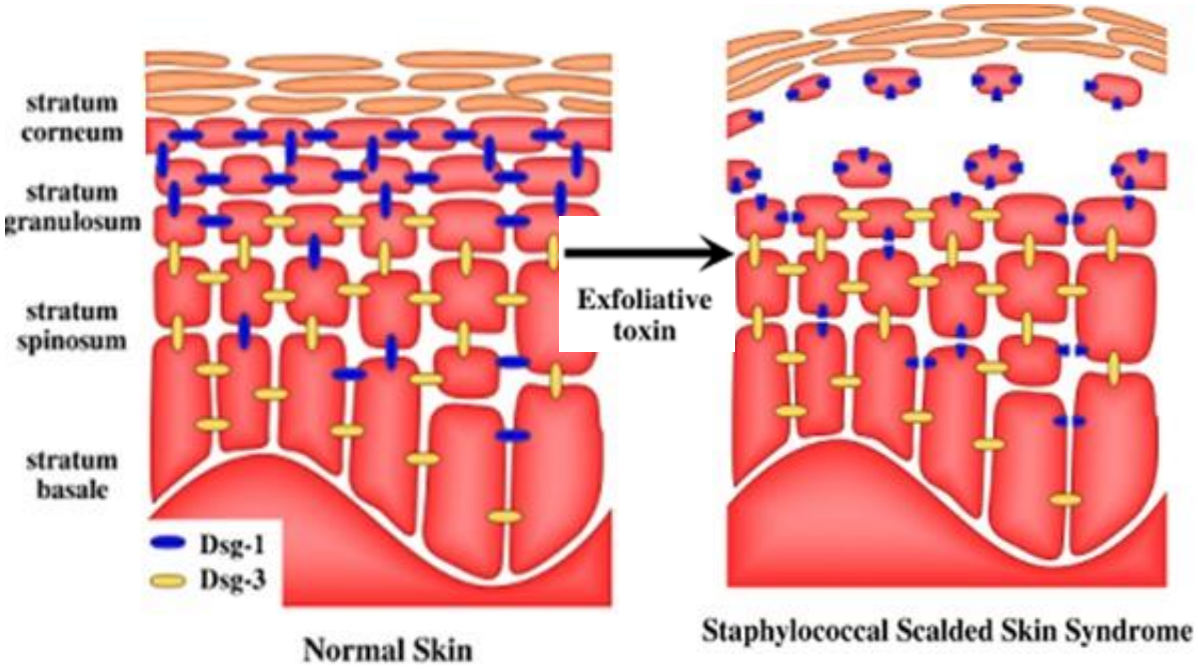
  S. aureus from asymptomatic carriers (babies and adults).
- **Treatment**

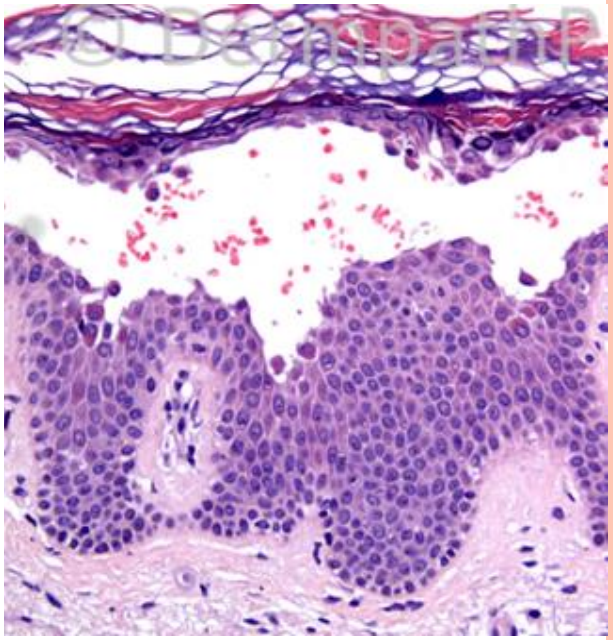
  Conservative measures include rehydration, antipyretics, and antibiotics that cover *S. aureus.*

Staphylococcus aureus

Levels of skin infections

Pathogenesis of SSSS





Staphylococcus aureus

Levels of skin infections

Toxigenic disease

Staphylococcal scalded skin syndrome (SSSS)

The face, axilla, and groin tend to be affected first, but the erythema, bullous formation, and subsequent desquamation of epithelial sheets can spread to all parts of the body.

Levels of skin infections

Toxigenic disease

2- Toxic shock syndrome (TSS)

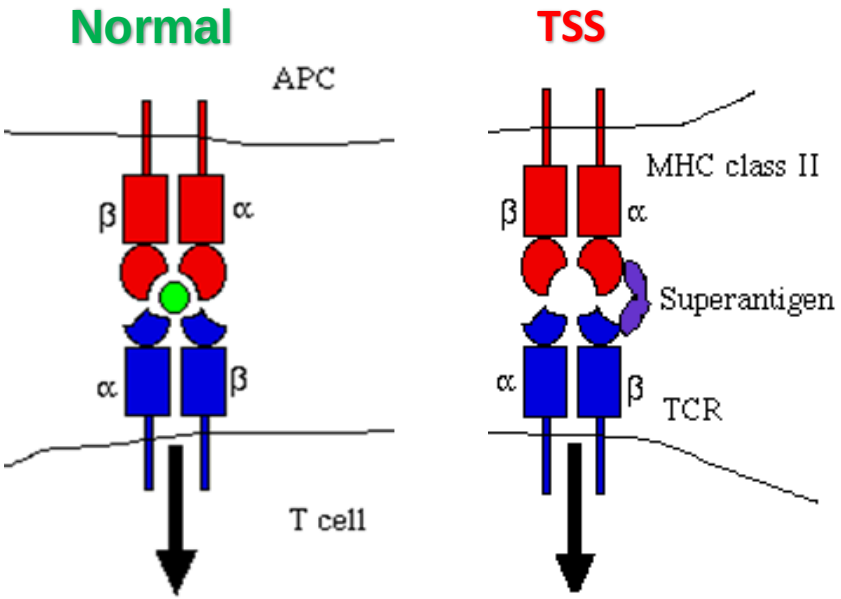
- *S. aureus enterotoxin type B* and *S. pyogenes*
- **Toxic shock syndrome toxin-1 (TSST-1): Superantigen**
- Produced in the primary infection site

Staphylococcus aureus

Levels of skin infections

Toxic shock syndrome (TSS)

Mechanism



Monoclonal T-cell activation

Polyoclonal T-cell Activation
up to 20% of the body's T-cells can be activated at one time

↓

Strom of cytokines → Immunotoxicity

Staphylococcus aureus

Levels of skin infections

Toxic shock syndrome (TSS)

Toxigenic disease

Symptoms

❖ TSS has an abrupt onset of fever, vomiting, diarrhea , and muscle pain, Hypotension, heart failure and renal failure may occur in severe cases.

❖ Skin manifestations include a rash followed by desquamation of the skin (sunburn-like rash), particularly soles and palms(S. aureus)

Treatment

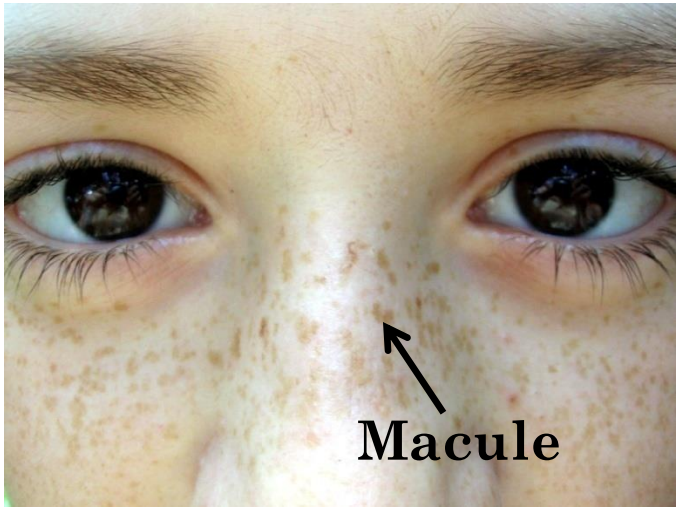
❖ Admission to the intensive care unit is often necessary for supportive care for fluid management, ventilation, renal replacement therapy

❖The source of infection should be removed or drained if possible

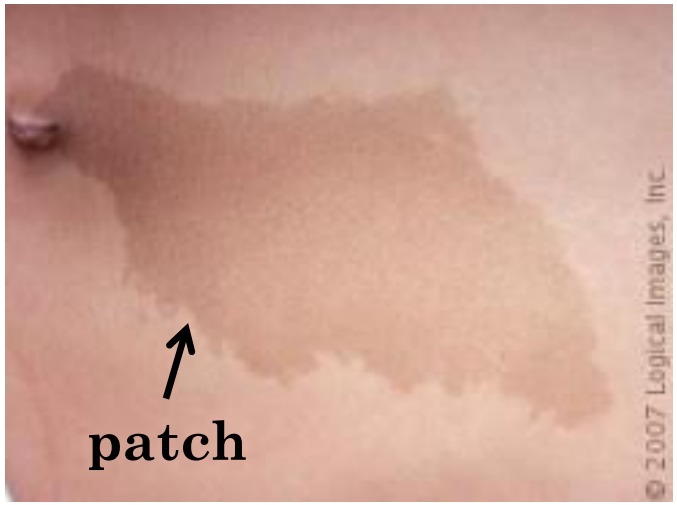
❖Antibiotic treatment should cover both *S. pyogenes* and *S. aureus*

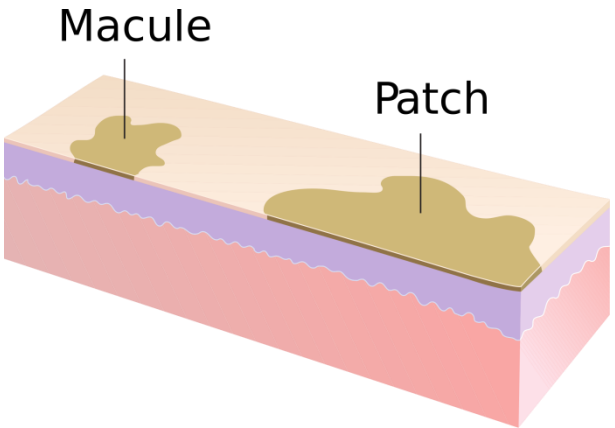
Definitions

Macule & patch
Is a change in the color of the skin and you could not detect it by touch.
A macule greater than 1 cm. may be referred to as **a *patch***.



Freckle

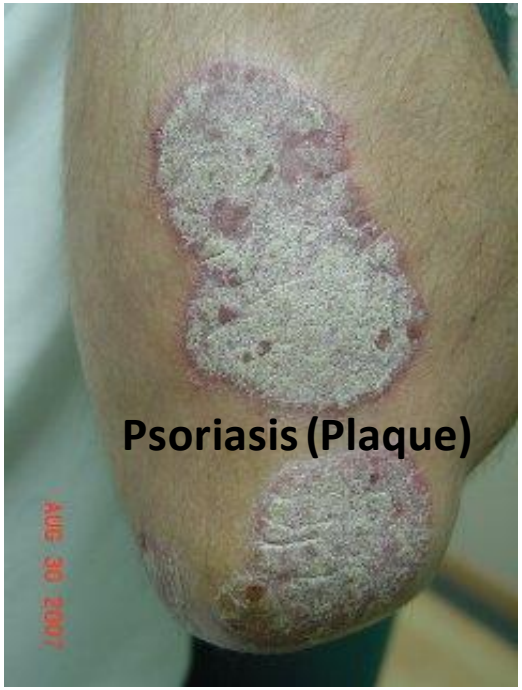


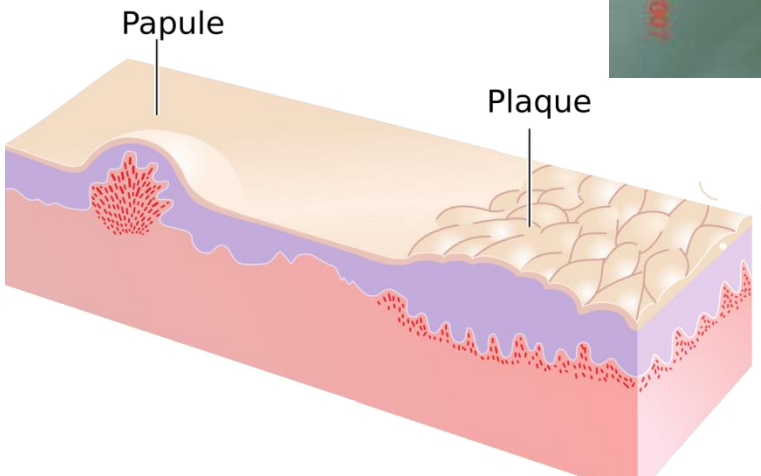


Definitions

Papule & Plaque

Papule: is a circumscribed, solid elevation of skin with no visible fluid, varying in size from a pinhead to 1 cm. They can be brown, purple, pink or red in color.
Plaque: is a solid, raised, flat-topped lesion greater than 1 cm. in diameter.





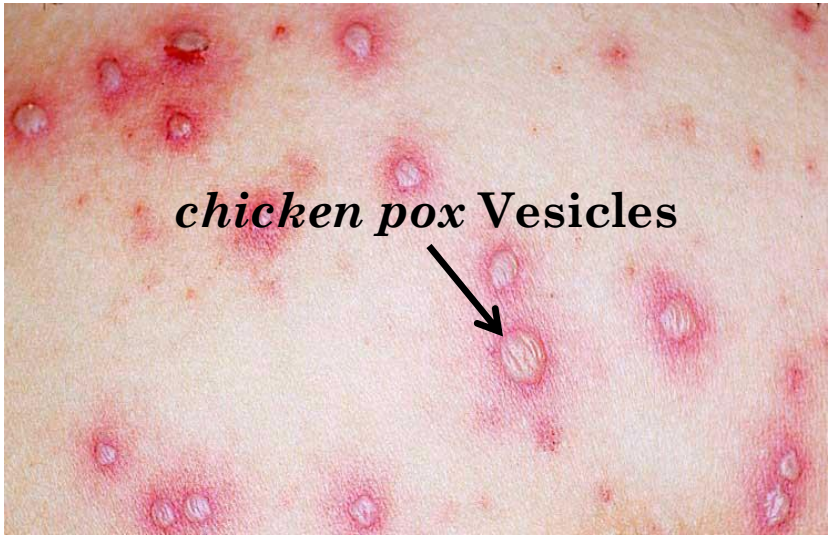
Definitions

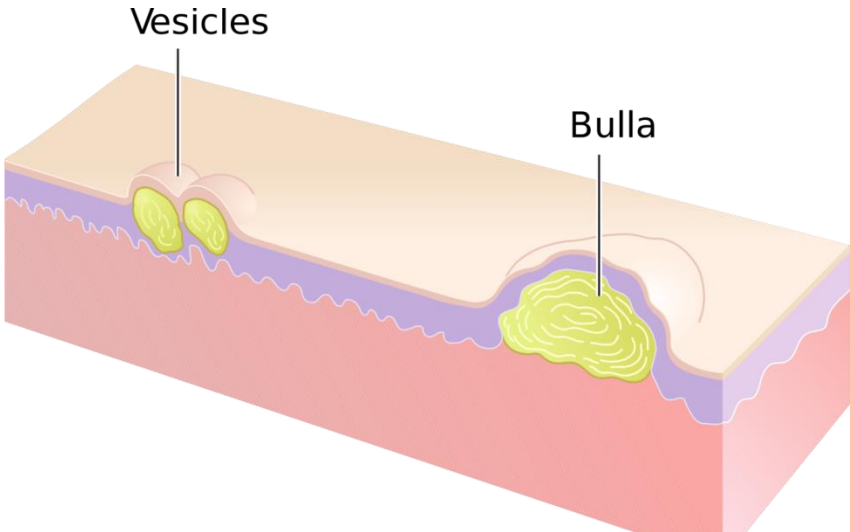
Vesicle & Bulla

Vesicle : is a small fluid-containing blister

Bulla: is a large fluid-containing blister

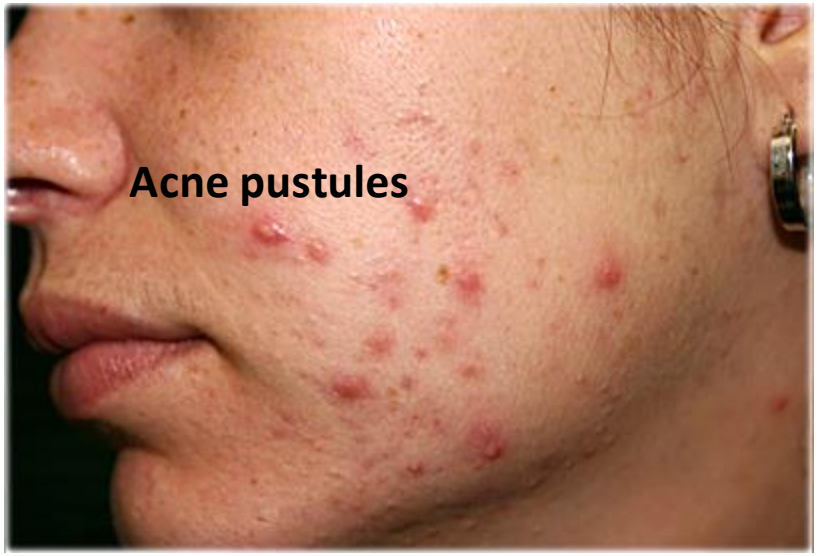
Burn Bullae





Definitions

Pustule: blister containing puss



Crust : dried exudates from a vesicle, bulla, or pustule.

THANK YOU