

STAPHYLOCOCCI



MaheshYadav

Medical Microbiology

Central Dept. Of Microbiology

TU, Nepal

INTRODUCTION



- **Family:** Micrococceae (consists of Gram positive cocci, arranged in tetrads, clusters)
- **Genus :** Staphylococcus
- Term “staphylococcus” derived from Greek :**Staphyle** = bunch of grapes and **Kokkos** = berry, meaning bacteria occurring in grapelike clusters or berry.

History



- **Robert Koch (1878)**- first to see staphylococci in pus specimen



- **Louis Pasteur (1880)**- first to cultivate in liquid medium



- **Sir Alexander Ogston (1881)**- named the bacteria as “staphylococcus”

Classification

- Based on pigment production:
 - *S.aureus* :-golden-yellow pigmented colonies
 - *S.albus* :- white colonies
 - *S.citrus* :-lemon yellow colonies
- Based on pathogenecity:
 - Pathogenic:- includes only one i.e., *S.aureus*
 - Non-pathogenic:- includes *S.epidermidis*, *S.saprophyticus*, *S.albus*, *S. citrus*, *S.hominis*,etc.
- Based on coagulase production:
 - Coagulase positive: *S. aureus*
 - Coagulase negative: *S. epidermidis*, *S. saprophyticus*



S. albus , *S. aureus* , *S. citrus* on Nutrient Agar

S. aureus

- Natural habitat:-Nostril and skin

Morphology:-

- Gram-positive, cocci, 0.5-1.5 μ m in diameter; occur characteristically in group, also singly and in pairs
- Form irregular grapelike clusters (since divide in 3 planes)
- Non-motile, non- sporing and few strains are capsulated

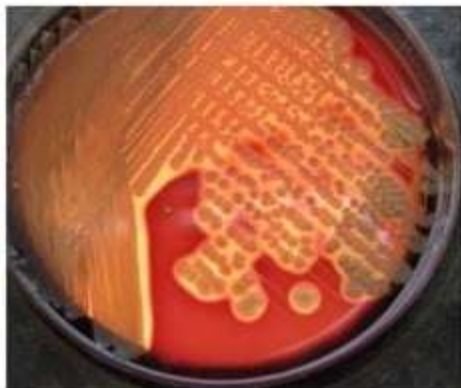
Culture

- Aerobes and facultative anaerobes
- Opt. Temp. For growth= 37°C
- Opt. pH for growth= 7.5
- **On Nutrient agar,**
 - golden yellow and opaque colonies with smooth glistening surface, 1-2 mm in diameter (max. pigment production@22 °C)



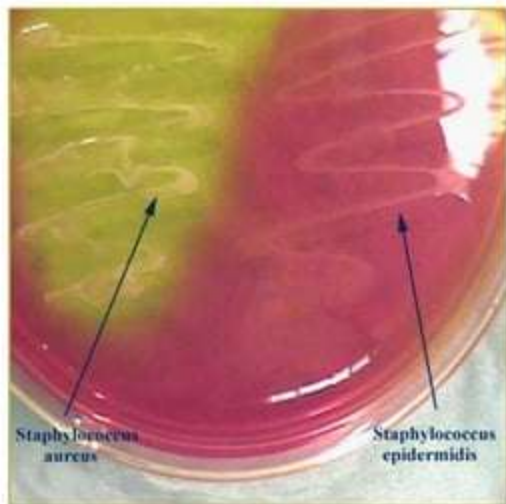
Culture (contd...)

- On Blood agar,
 - golden yellow colonies, surrounded by a clear zone of hemolysis (beta-hemolysis), esp. When incubated in sheep or rabbit blood agar in atmosphere of 20% CO₂
- On MacConkey agar,
 - Smaller colonies than those on NA(0.1-0.5 mm) and are pink coloured due to lactose fermentation



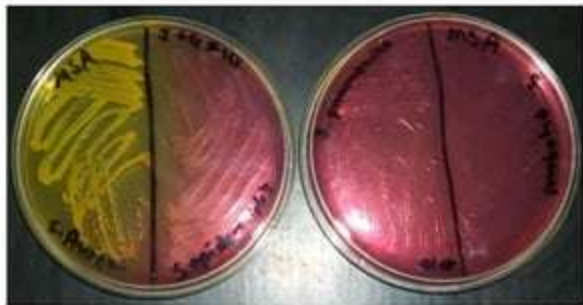
Culture (...contd)

- On Mannitol salt agar,
 - *S.aureus* ferments mannitol and appear as yellow colonies
 - MSA is a useful selective medium for recovering *S.aureus* from faecal specimens, when investigating food poisoning



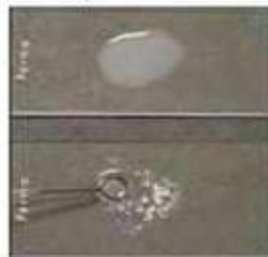
Biochemical Properties

- Catalase positive;
oxidase negative
- Ferment glucose, lactose, maltose, sucrose and mannitol, with production of acid but no gas
- Mannitol fermentation carries diagnosis significance



Biochemical Properties(...contd)

- Indole test= negative
- MR test= positive
- VP test= positive
- Urease test= positive
- Hydrolyse gelatin
- Reduces nitrate to nitrite
- Phosphatase= positive
- DNA-ase test= positive
- Coagulase test= positive



Slide test (clumping factor)



Tube test (free coagulase)

Virulence Factors

Cellwall associated structures

- Peptidoglycan
- Capsule
- proteinA
- Clumping factor (bound coagulase)

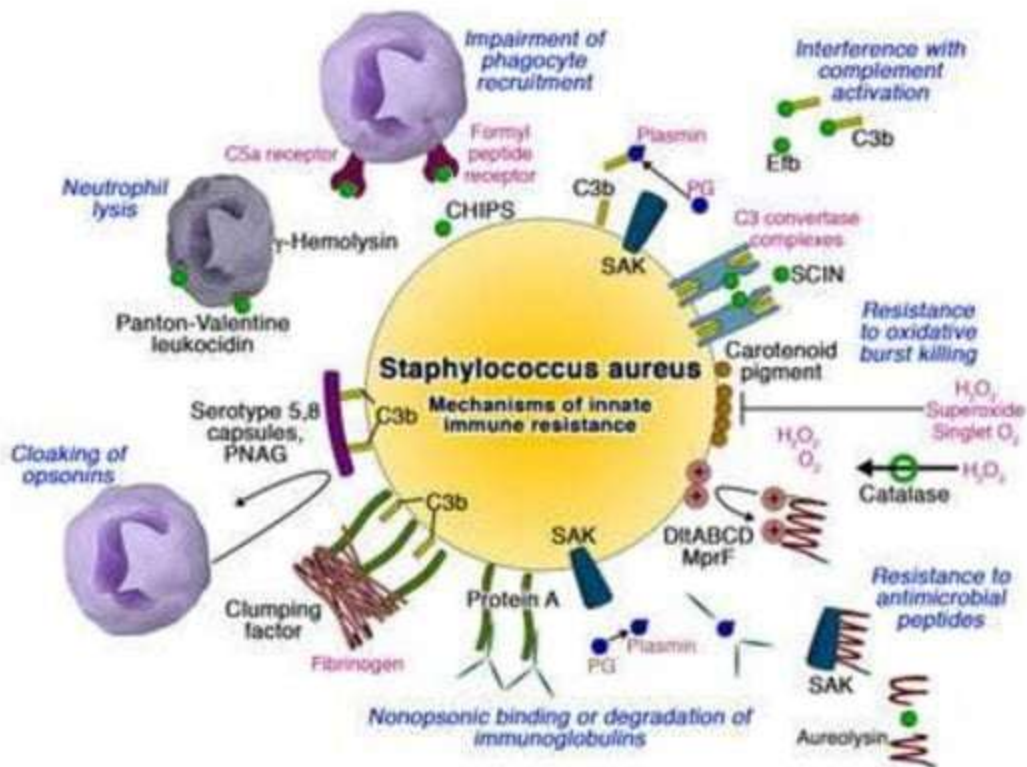
Extracellular toxins

- Haemolysin
- Leukocidin
- Enterotoxin
- TSST
- Exfoliatin toxin

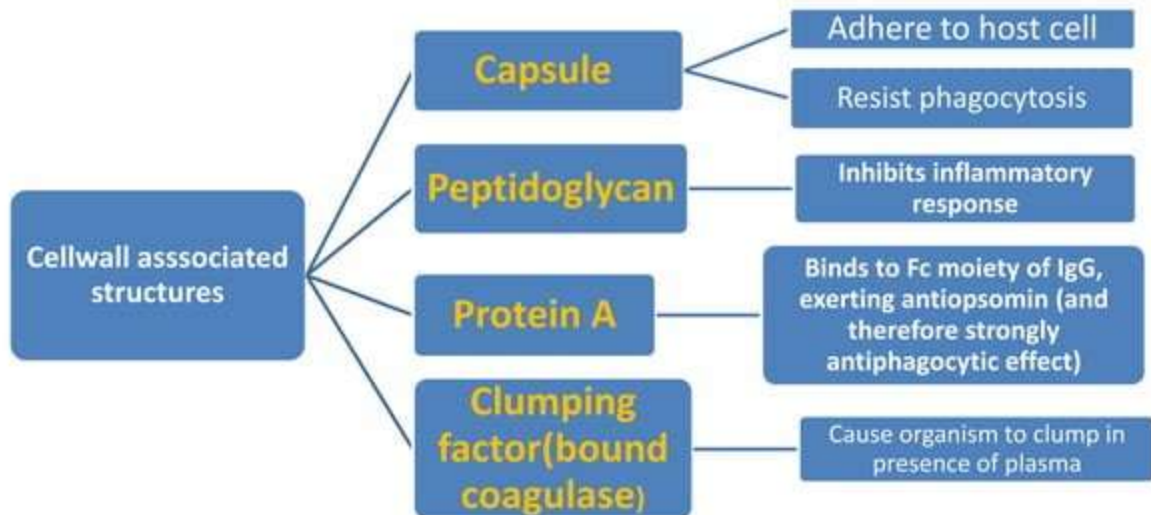
Coagulase

- staphylokinase
- DNAase
- Phosphatase
- lipase
- Phospholipase
- hyaluronidase
- serokinase
- protease

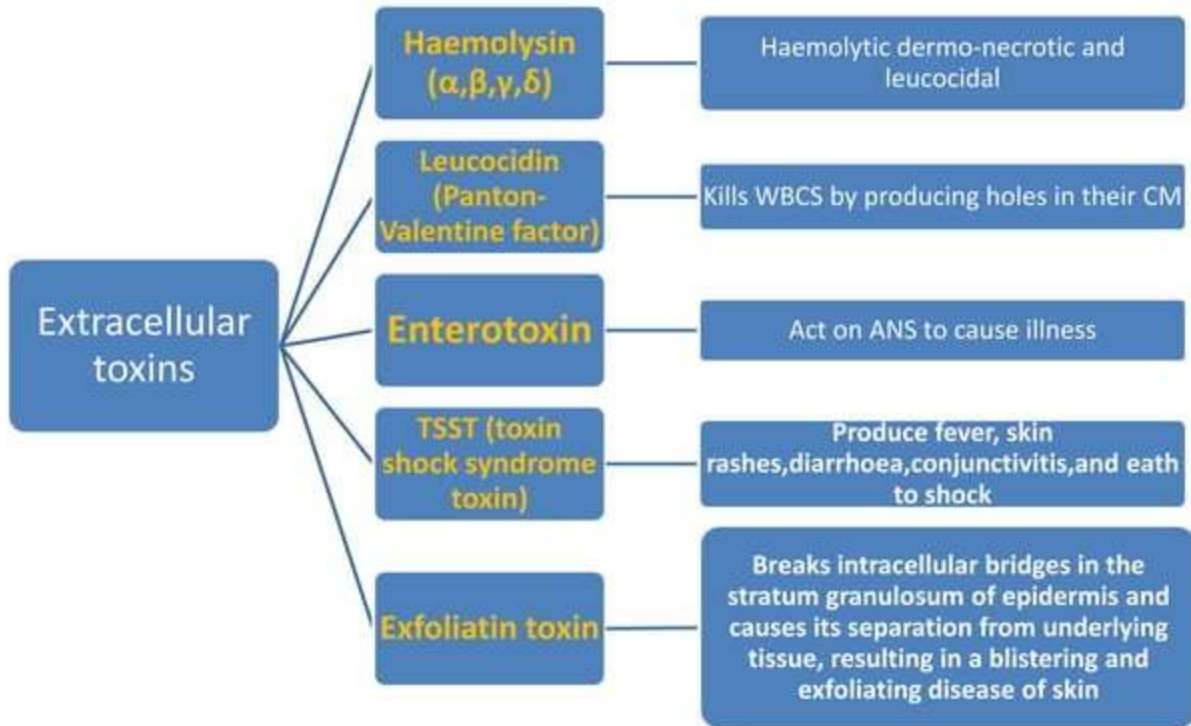
Virulence Factors



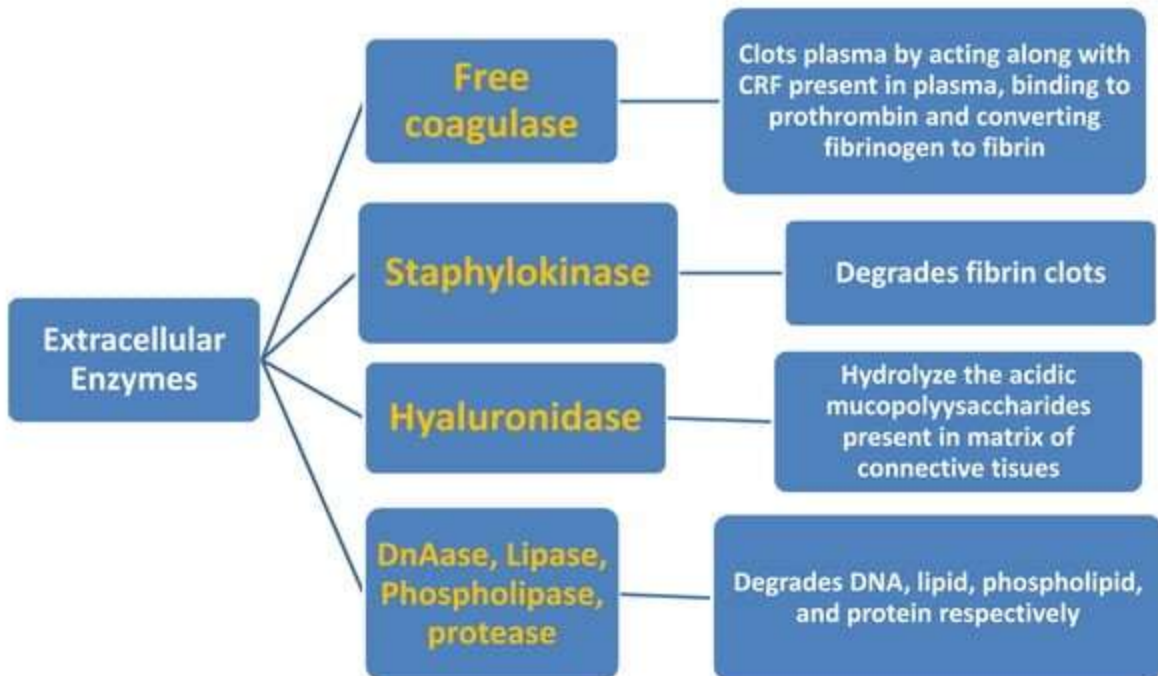
Virulence Factors(contd....)



Virulence Factors(contd....)



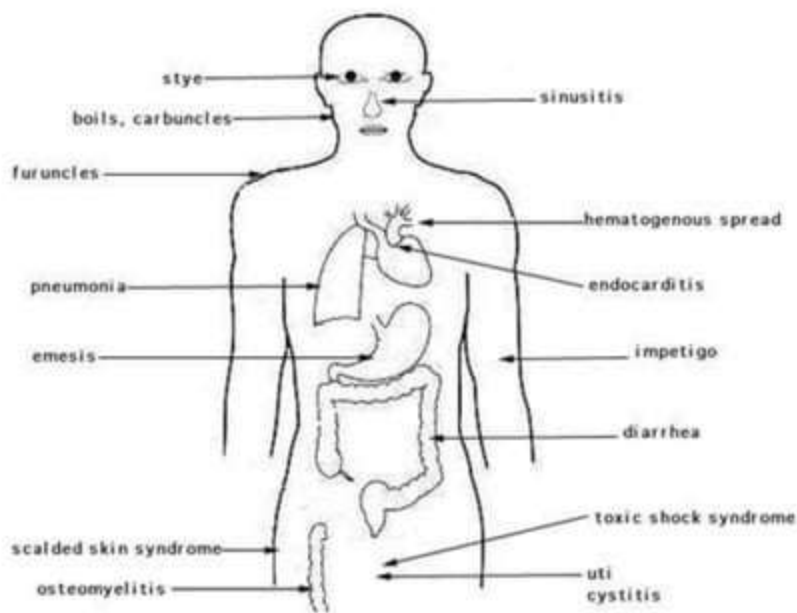
Virulence Factors(...contd)



Pathogenesis

- Adhere to damaged skin, mucosa or tissue surfaces
 - At these sites, they evade defence mechanisms of the host, colonize and cause tissue damage
- *S.aureus* produces disease by
 - Multiplying in tissues
 - Liberating toxins,
 - Stimulating inflammation

Clinical Syndromes



Clinical Syndromes

1. Cutaneous infections

- Folliculitis
- Boils/furuncles
- Carbuncle
- Impetigo
- Wound infections

2. Deep infections

- Osteomyelitis
- Periostitis
- endocarditis

3. Exfoliative diseases

4. Toxin shock syndrome

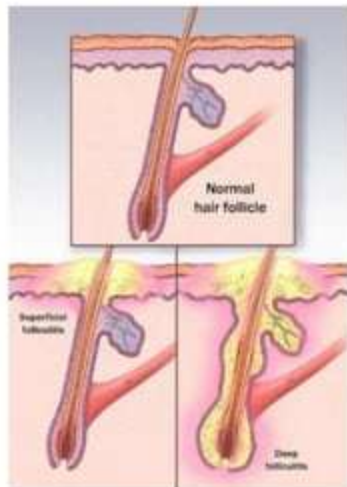
5. Staphylococcal food intoxication

1) Cutaneous Infections

- **Folliculitis:** It is inflammation of the hair follicles.
- A small red bump or pimple develops at infection sites of hair follicle.



- **Sty:** A sty is folliculitis affecting one or more hair follicles on the edge of the upper or lower eyelid.



Cutaneous Infections(contd....)

- **Furuncle/boils:** Furuncle is **deep seated** infection, originating from folliculitis,(if infection extends from follicle to neighbour tissue)
- Causes redness, swelling, severe pain
- Commonly found on the neck, armpit and groin regions

- **Carbuncle:** Carbuncle is an aggregation of infected **furuncles**. Carbuncles may form large abscesses.
- It is a large area of redness, swelling and pain, punctuated by several sites of drainage pus.



Cutaneous Infections(contd....)

- **Impetigo:** a very superficial skin infection common in children, usually produces blisters or sores on the face, neck, hands, and diaper area.
- It is characterized by watery blisters, which become pustules and then honey coloured crust



impetigo with vesicles, pustules, and sharply demarcated regions of honey-colored crusts.

2) Deep Infections

- **Osteomyelitis:**
inflammation of bone
- Bacteria can get to the bone
 - Via bloodstream
 - Following an injury

Clinical features: pain, swelling, deformity, defective healing, in some case pus flow,

Diagnosis: X-ray, MRI, bone aspirates



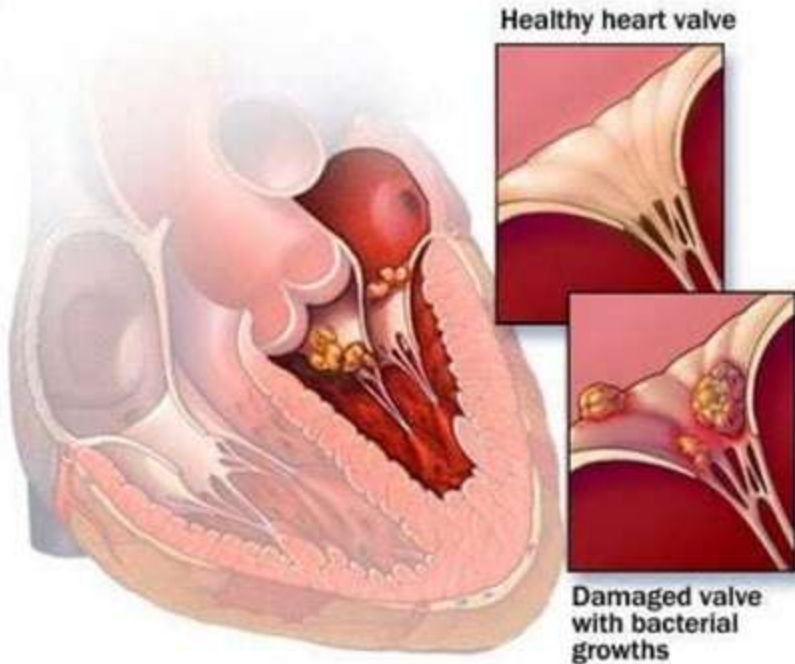
Deep Infections(contd....)

- **Periostitis**: inflammation of periosteum
- **Clinical features**: fever, localised pain, leucocytosis
- **Diagnosis**: needle aspiration of subperiosteal fluid



Deep Infections(....contd)

- **Endocarditis:** It is an inflammation of the inner layer of the heart, the endocardium
- Endocarditis occurs when bacteria enter bloodstream, travel to heart, and lodge on abnormal heart valves or damaged heart tissue.



3)Exfoliative Disease

- (Exfoliate= scaling off tissues in layers)
- Also known as '**Staphylococcal skin scalded syndrome**'
- previously called dermatitis exfoliativa, pemphigus neonatorum, Lyell's disease and Ritter's disease
- Epidermal toxin produced by *S.aureus* at skin and is carried by bloodstream to epidermis , where it causes a split in a cellular layer i.e., this toxin separates outer layer of epidermis from underlying tissue



4) Toxic Shock Syndrome

- Caused when Toxin shock syndrome toxin (TSST) liberated by *S.aureus* enters bloodstream
- It is a multisystem illness, characterized by:



High Fever



Headache



Vomiting



Diarrhoea



Conjunctival
reddening



Hypotension



Skin rashes



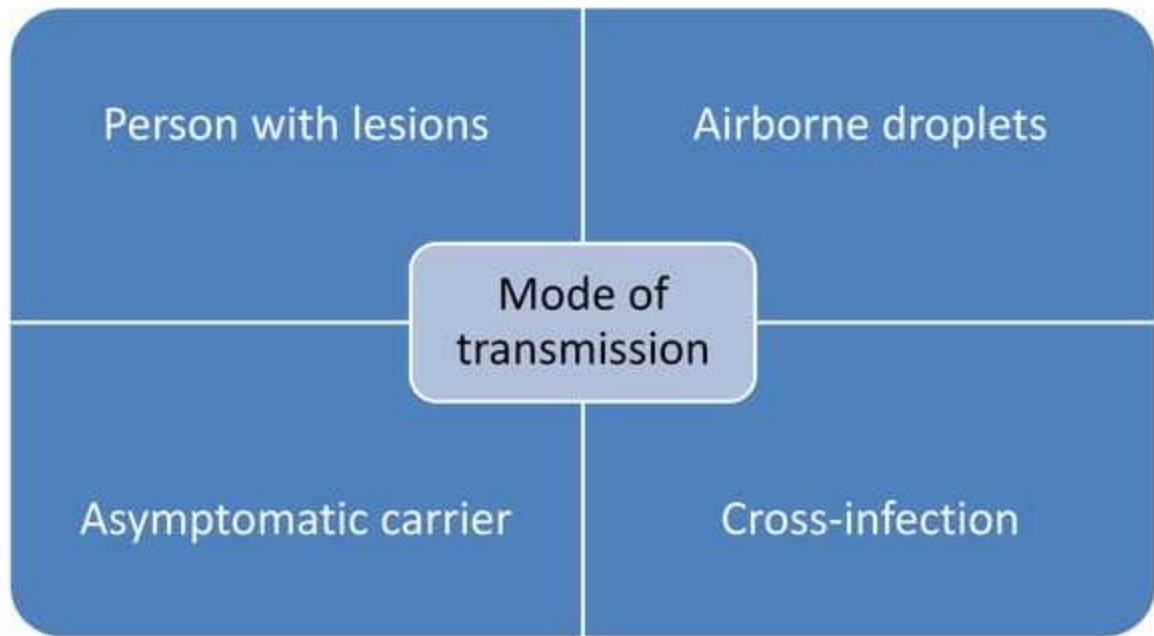
Kidney failure

5) Staphylococcal Food Poisoning

- Caused when consuming food in which *S.aureus* has multiplied and formed endotoxin
- Symptoms:
 - Nausea
 - Vomiting
 - Severe abdominal cramp
 - Diarrhoea
 - Sweating
 - Headache, etc.



Mode Of Transmission



Prevention



**Wash your
hands**



**Keep wounds
covered**



**Reduce tampon
risks**



**Avoid sharing
personal care items**



**Cooking and storing
food properly**

Treatment and Drugs



Antibiotic therapy



Wound drainage



Device removal



Removal of dead tissue

Laboratory Diagnosis

A. Haematological Investigation:

1. TLC (Total leukocyte count):

Normal: 4000-10000 cells/mm³

In case of infection: > 10000 cells/mm³

2. DLC (Differential leukocyte count):

Normal neutrophil : 80%

In case of infection: > 80%

Laboratory Diagnosis (contd....)

B. Bacteriological Investigation:

- Specimens:
 - Pus: from wound or abscess or burns]
 - Nasal Swab: from suspected carrier
 - Food: to diagnose staphylococcal intoxication
 - Blood: to diagnose endocarditis and bacteremia
 - Sputum: to diagnose lower respiratory tract infection



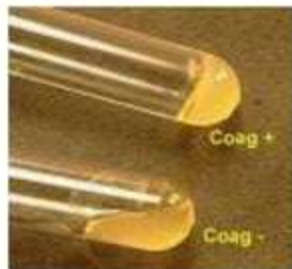
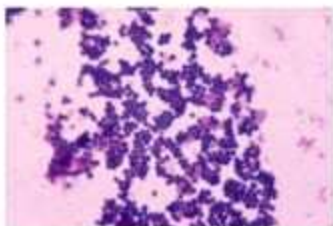
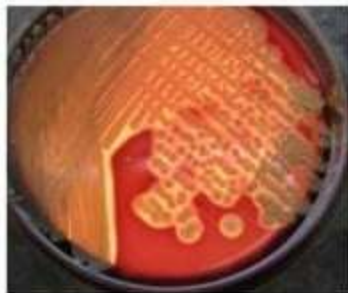
Laboratory Diagnosis (contd....)

- **Culture and isolation:**

- Specimens are **cultured on BA** plate and are incubated @ 37 °C for 24 hours
- After incubation, BA plate is observed for significant bacterial growth (> 2mm in diameter)
- Then, **Gram-staining** is performed of the isolated organisms
- Then, subcultured on NA plate for further biochemical tests

- **Tube coagulase test:**

- i. Mix 0.5ml of human plasma with 0.1ml of an overnight broth culture of *S.aures*
- ii. Incubate the mix in a water bath @ 37°C for 3-6 hours
- Result: plasma clots and doesn't flow if the tube is inverted



MRSA

- Most strains of *S.aureus*, even those acquired in community, are penicillin resistant
 - Resistance is attributable to beta-lactamase production due to genes located on extrachromosomal plasmids.
- Some are resistant to the newer beta-lactamase resistant semisynthetic penicillins, such as methicillin, oxacillin, nafcillin.
 - Resistance is due to presence of unusual penicillin-binding protein(PBP)in the cellwall of resistant strains
- Infection with MRSA is likely to be more severe and require longer hospitalization, with incumbent increased costs than infection with a methicillin susceptible strain.

CONS

- Coagulase Negative Staphylococci(CONS) that are commonly implicated as pathogens include
- *Staphylococcus epidermidis*: causes infection of native heart valves and intravascular prostheses.
- *Staphylococcus saprophyticus*: causes urinary tract infections, mainly in sexually active women.
- CONS that are less commonly implicated as pathogens include: *S.hominis*, *S.haemolyticus*, *S.cohnii*, *s.lugdunensis*, *S.saccharolyticus*, *S.schleiferi*, *S.simulans* and *S. warneri*

THANK

YOU