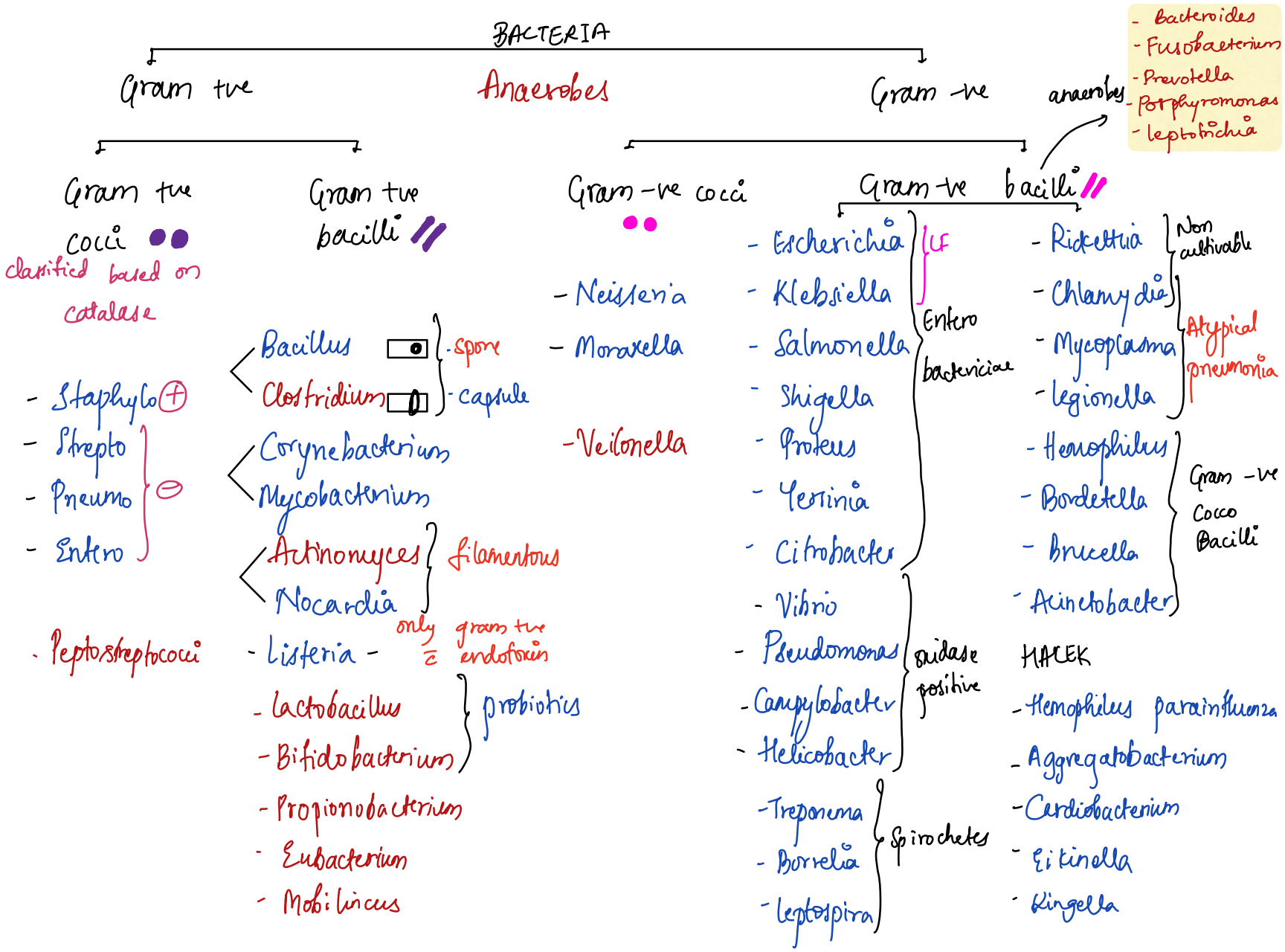

BACTERIA
Gram +ve
Anaerobes
Gram -ve
Gram +ve cocci
classified based on catalase
Gram +ve bacilli
- Staphylo ⊕
- Strepto
- Pneumo
- Entero
⊖
- Peptostreptococci
Bacillus
Clostridium
- spore
- capsule
Corynebacterium
Mycobacterium
Actinomyces
Nocardia
filamentous
- Listeria -
only gram +ve ∈ endotoxin
- Lactobacillus
- Bifidobacterium
probiotics
- Propionobacterium
- Eubacterium
- Mobiluncus
Gram -ve cocci
- Neisseria
- Moraxella
- Veilonella
Gram -ve bacilli
anaerobes
- Bacteroides
- Fusobacterium
- Prevotella
- Porphyromonas
- leptotrichia
- Escherichia
- Klebsiella
- Salmonella
- Shigella
- Proteus
- Yersinia
- Citrobacter
LF
Entero bactericiae
- Vibrio
- Pseudomonas
- Campylobacter
- Helicobacter
oxidase positive
-Treponema
- Borrelia
- leptospira
Spirochetes
- Rickettsia
- Chlamydia
- Mycoplasma
- legionella
Non cultivable
Atypical pneumonia
- Haemophilus
- Bordetella
- Brucella
- Acinetobacter
Gram -ve Cocco Bacilli
HACEK
- Hemophilus parainfluenza
- Aggregatobacterium
- Cardiobacterium
- Eikinella
- Kingella

Lactose fermenters - 1) Escherichia
Klebsiella trifecta - 2) Klebsiella } LF
KESH 3) Enterobacter }
Serratia } NLF
Hafnia }

Late lactose fermenters - Citrobacter
Shigella sonnei

Non lactose fermenters - rest all Gram -ve bacilli

HACEK
- Hemophilus parainfluenza } catalase +, oxidase (-) } commensals of oral cavity
- Aggregatobacterium
- Cardiobacterium } catalase -ve, oxidase +ve
- Eikinella
- Kingella

predisposing : Injury factor
↓
lead to SABE

DOC - Ceftriaxone

mc anaerobe causing infection - Bacteroides (capsulated)

## Catalase Negative

1) Streptococcus
2) Pneumococcus
3) Enterococcus
4) Cardiobacterium
5) Eikinella
6) Kingella

## Oxidase positive

1) Neisseria
2) Moraxella
3) Vibrio
4) Pseudomonas
5) Campylobacter
6) Helicobacter
7) Cardiobacterium
8) Eikinella
9) Kingella
10) Hemophilus
11) Bordetella
12) Brucella

Fermenter – ferments glucose
If can't ferment glucose
can't ferment any sugar
Non-fermenters (oxidizers)
- Pseudomonas (≈ Burkholderia, Stenotrophomonas)
- Bordetella
- Brucella
- Acinetobacter

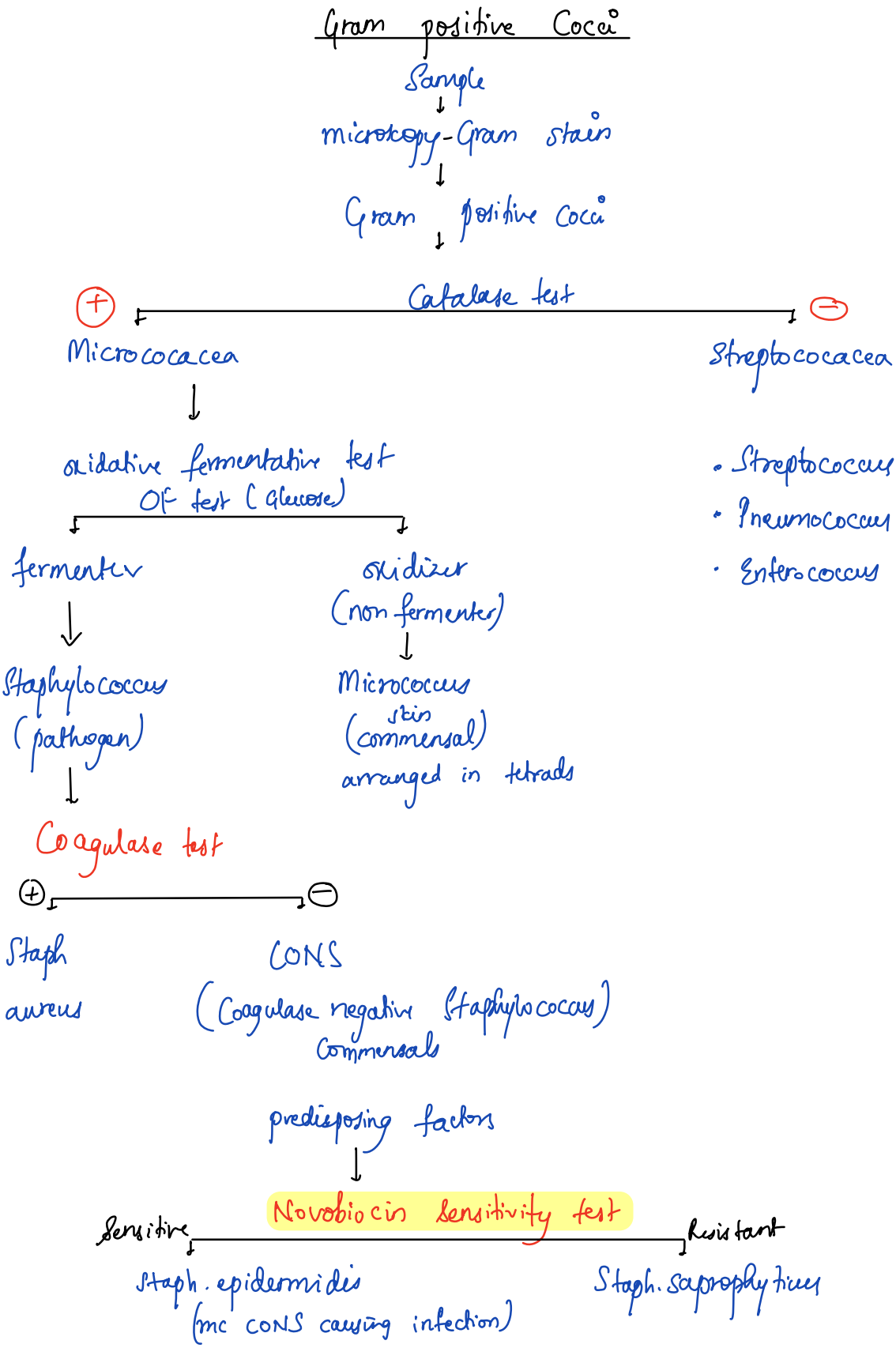
## VP true

Voges Proskauer test

1) KESH
   - K Klebsiella
   - E Enterobacter
   - S Serratia
   - H Hafnia
2) Yersinia enterocolitica
3) Vibrio ELTOR

## Anaerobes

1) Peptostreptococci
2) Veilonella
3) Lactobacillus
4) Bifidobacillus
5) Bacteroides
6) Fusobacterium
7) Propionibacterium
8) Eubacteria
9) Mobilincus
10) Prevotella
11) Porphyromonas
12) Leptotrichia
13) Actinomyces
14) Clostridium


Gram positive Cocci
Sample
microscopy - Gram stain
Gram positive cocci
Catalase test
+
-
Micrococacea
Streptococacea
oxidative fermentative test
Of test (glucose)
fermenter
oxidizer
(non fermenter)
Staphylococcus
(pathogen)
Micrococcus
skin
(commensal)
arranged in tetrads
Coagulase test
+
-
Staph
aureus
CONS
(Coagulase negative Staphylococcus)
Commensals
predisposing factors
Novobiocin sensitivity test
Sensitive
Resistant
Staph. epidermidis
(mc CONS causing infection)
Staph. saprophyticus
• Streptococcus
• Pneumococcus
• Enterococcus

# CONS

| Staph epipermidis | Staph. Saprophyticus |
| --- | --- |
| mc CONS causing infection<br>- Skin commensal | - female urethra commensal |
| predisposing factor:<br>- Injury - SSI<br>(Surgical site infection)<br>mc organism - staph. aureus<br>causing SSI staph. epidermidis | predisposing factor:<br>- Injury - frequent sexual intercourse<br>(young female - married)<br>causes UTI |
| - Novobiocin sensitive | - Novobiocin resistant |

# Staphylococcus aureus

Virulence factors:

1) Cell surface factor: Protein A → antiphagocytic
   ↘ binds to Fc portion of Ab


→ Ab coated ~ protein A used to detect antigens

2) Enzymes

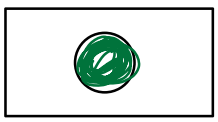
a) Coagulase — most constantly associated virulence factor

prothrombin like activity

fibrinogen → fibrin (clot)

BOUND (to surface) (aka clumping factor) — FREE (released into blood)

+ plasma ↓ Slide agglutination (does not require CRF) (coagulase reacting factor)

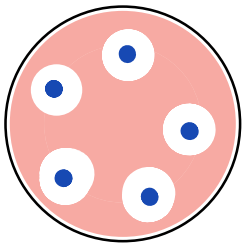


+ plasma ↓ Tube agglutination (requires CRF)

b) DNase
c) Hyaluronidase
d) Staphylokinase
} less effective

3) Toxins

a) Hemolysins → hemolysis



- α - hemolysis
- β - hot & cold phenomenon
  - produced @ 4°C ∴ on refrigeration – ↑sed zone of hemolysis
- γ
- δ
- Panton valentine toxin

γ toxin
PV toxin
} Synergohymenotropic toxins

b) TSST - Type I
(Toxic shock syndrome toxin)

Superantigen → exaggerated immune response
↓
Toxic shock syndrome

c) Enterotoxin — 8 types — A-mc type [A, B, $C_1$, $C_2$ ....]
- Superantigen
- Gastroenteritis (food poisoning)
- It is a preformed toxin (already present in food) (∵ incubation period is short) 1–6 hrs
- heat stable toxin

Mechanism: Enterotoxin stimulates
- CTZ → vomiting
- Vagus nerve → ↑ed peristalsis → diarrhoea

Rx:
- mild → Symptomatic Rx
- Severe → Antitoxin + Antibiotic

d) Exfoliative toxin → Staphylococcal Scalded Skin syndrome

mild —untreated→ severe

children: pemphigus like lesions —untreated→ Ritter's disease

adult: Bullous impetigo like lesions —untreated→ Toxic epidermal Necrolysis

Clinical manifestations :

Skin — Folliculitis, Furuncle, Carbuncle
Bullous impetigo & Non-bullous impetigo
Botryomycosis

Systemic

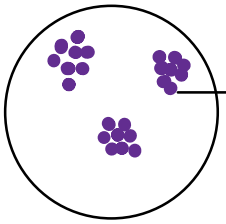
- CVS - Infective endocarditis
  - native valve
    - (N) healthy
    - iv drug abuse
    - → Staph aureus
  - prosthetic valve
    - < 12 months - Staph. epidermidis (CONS)
    - > 12 months - Strept. viridans
- RS - Nosocomial pneumonia (bronchopulmonary pneumonia) — carriers
  - Nasal
  - Skin
- Musculoskeletal system - Osteomyelitis (mc organism)

- prevention - handwashing - best method
- Treat the carriers
  - Nasal - 2% mupirocin
  - Skin - 4% chlorhexidine

Septicemia - not toxin mediated

Δ^sis :

- Microscopy :



Gram +ve cocci in clusters

- Culture :

Selective media →
- Mannitol Salt agar
- Ludlam's Medium
- Salt Milk agar

Salt tolerance - 10% NaCl

On nutrient agar →
- Golden yellow pigment
- oil paint appearance

On Blood agar → Beta-hemolysis | On nutrient agar → Golden yellow pigment | On MSA → Yellow colonies

Pigment production
- occurs optimally @ 22° (due to β carotene)
- enhanced when 1% glycerol or milk is incorporated in the medium

Typing : identification beyond species

- Biotyping & biotypes (A, B, C, D .....)

me type - A

- Bacteriophage typing

Phage 80 & 81 types → Nosocomial infection

Note: Transmission based precautions

| Contact based isolation | Droplet based isolation | Airborne precaution |
|---|---|---|
| - MRSA | - Diphtheria | - Measles |
| - VRSA | - Mumps | - TB |
| - VRE | - pertussis | - Chickenpox |
| - RSV | - Mycoplasma | |
| - Diarrhoeal illness | | |
| - Open wounds | | |

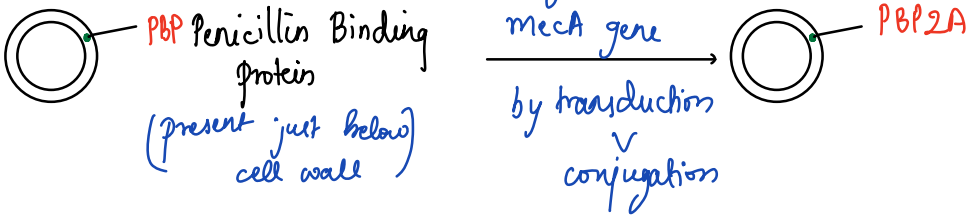
**MRSA** - Methicillin Resistant Staphylococcus aureus

Defn: Staph aureus resistant to all β-lactam antibiotics

- penicillins
- cephalosporins
- Monobactam
- Carbapenem

} cell wall inhibitors

Mechanism: Gene transfer




mecA gene - on SCC
(Staphylococcal chromosomal Casette)

Dx: Phenotypic — Cefoxitin disc method (mc used)
Resistant → MRSA

Genotypic — PCR → mecA gene → present — MRSA

DOC:

Rx: - Glycopeptides — Vancomycin — D-ala D-ala (binding site) - cell wall inhibitors

- Daptomycin (cell membrane) inhibitor

↓
D-ala D-lac — VRSA

- Linezolid & Streptogramins — protein inhibitors
- 5th gen Cephalosporins

Note: Superbug - resistant to all antibiotics

Sample

microscopy - G/S Gram positive cocci

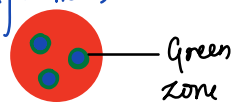
Catalase test

(+) Micrococcacea

(−) Streptococcacea

Brown's classification ← Hemolysis on blood agar

## α hemolysis (partial)




- Streptococcus viridans (commensal)

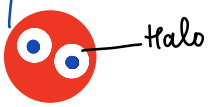
Subtypes:

- S.v salivarius (longest chains)
- S.v mutans (Dental caries)
- S.v milleri (IE in prosthetic valve >12 months)

- Streptococcus pneumoniae
  - Optochin sensitivity (+)
  - Bile solubility (+)
  - Inulin fermentation (+)

If negative → viridans

## β hemolysis (complete)




Lancefield classification

20 groups

(based on Carbohydrate Ag)

→ Group A → All inf. (Strept. pyogenes)

↳ Bacitracin sensitivity (+)

Griffith classification

>100 serotypes based on (M, T, R proteins)

→ Group B → Neonatal meningitis (Strept. agalactaceae)

↳ cAMP test (+)

other groups - non pathogenic

## γ hemolysis (no hemolysis)

Enterococcus

Group D streptococcus

gram +ve cocci in pairs

Spectacle shaped

E. fecalis - MC infection

E. fecium - most drug resistant & (vancomycin resistant)

Tolerance:

- 6.5% NaCl
- 40% Bile
- Bile Esculin (+)
- PYR (+)
- Heat stable

# Streptococcus

Virulence factors:

1) Cell surface factor : Protein M — antiphagocytic

2) Enzymes
- DNase (A, B, C, D) – breakdown of DNA (watery pus) [∴ DNA - responsible for viscosity of pus]
  (Streptodornase)
  mc DNase responsible for virulence – Type B
- Hyaluronidase – breakdown of connective tissue
  spread of infection – cellulitis
- Streptokinase – fibrinolytic agent
  Group C streptococcus
  (Strept. equisimilis)

3) Toxins

a) Hemolysin — Streptolysin → Hemolysis

| Streptolysin S ($O_2$ stable) | Streptolysin O ($O_2$ labile) |
|---|---|
| - β hemolysis on Blood agar  | - not produced |
| - less immunogenic | - highly immunogenic (ASO) |

b) TSST – Type 2

Superantigen → exaggerated immune response

↓

Toxic shock syndrome

Clinical manifestations :

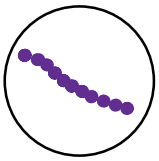
Group A Streptococcus pyogenes

- Throat - Pharyngitis → Acute Rheumatic Fever → Complication → ASO >200 IU titre
- Skin (Pyoderma) → PSGN → Anti DNase B, Anti hyaluronidase >350 IU titre
  - Cellulitis
  - Erysipelas
  - Erythrasma - Corynebacterium minutissimum
  - Ecthyma - Pseudomonas gangrenosum

Note: Dick test (skin) - susceptibility test for Streptococcus pyrogenic exotoxin / erythrogenic toxin → Superantigen
↳ basis for Dick test

Group B — Neonatal meningitis
Streptococcus agalactiae

Δsis : 1) Microscopy



Gram +ve cocci in chains

2) Culture — Selective : Crystal violet Blood Agar
Transport : Pike's medium

Note: Patients with S bovis endocarditis have increased incidence of colon cancer.

# Pneumococci

Gram positive cocci
arranged in pairs
capsulated

Virulence factor:
1) Capsule ⟶ antiphagocytic
2) IgA$_1$ proteases — breakdown mucosal IgA (local immunity)
3) Pneumolysin ⟶ cell lysis

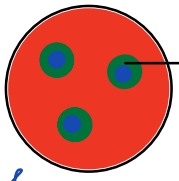
Clinical manifestations:
- Otitis media (mc manifestation)
- pneumonia
- meningitis

**IgA$_1$ proteases as virulence factor**
- pneumococci
- Meningococci
- Gonococci
- H. influenza

$\Delta^{sis}$:
Microscopy: Gram positive cocci arranged in pairs

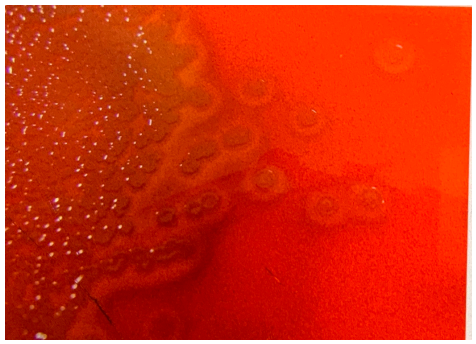
lens shaped

Culture: Blood Agar



$\alpha$ hemolytic / carrom coin / draughtsmann appearance

Factor responsible for bile solubility & draughtsman appearance: Autolysin
amidase enzyme that cleaves peptidoglycan, leading to autolysis of cells



Identification:
- Optochin sensitivity (+)
- Bile soluble (+)
- Inulin fermentation (+)

Vaccine
- Capsular PPSV - (pneumococcal polysaccharide vaccine)
  - CFI is <2 yrs
  - ∴ less immunogenic
- Conjugate PCV
  - Capsular + protein carrier → ↑ed immunogenecity

# Meningococci

**Meningitis & rash

Gram negative cocci arranged in pairs capsulated

- Lens shaped
- intracellular & extracellular

Virulence factor:
1) Capsule ⟶ antiphagocytic
2) IgA$_1$ proteases — breakdown mucosal IgA (Local immunity)
3) Endotoxin (LPS - Lipopolysaccharide)
   ↳ Septicemia, Shock

Clinical manifestation:
- asymptomatic carrier (mc manifestation)
- Skin rash
- Meningitis
- Septicemia, Shock
- * Waterhouse Friedrischen Syndrome
  - Skin rash, meningitis, Septicemia & shock
  - B/L Adrenal hemorrhage
  - Multiorgan failure

$\Delta^{sis}$:
Microscopy: Gram negative cocci arranged in pairs

- Lens shaped
- intracellular

Culture: Selective media: Thayer Martin fermentation, Modified New York medium

Identification: Maltose fermentation

Vaccine
- Capsular
  - bivalent — A, C
  - trivalent — A, C, W-135
  - tetravalent — A, C, Y, W-135
- Conjugate

C/I < 2yrs

CSF sample should not be exposed to extremes of temp

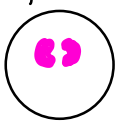
Rx: Empirical DOC - Ceftriaxone
DOC - Penicillin G
DOC for mass chemoprophylaxis - Ciprofloxacin

## Moraxella

- colonies on BA - Hockey Puck Sign
- Gram -ve cocci
- oxidase +ve

# Gonococci

Gram negative cocci arranged in pairs

 - kidney shaped

no capsule

mainly intracellular

Virulence factor: 1) pili (Any organism causing urogenital infection - pili is imp virulent factor ∵ otherwise washed away)

2) IgA$_1$ proteases — breakdown mucosal IgA (Local immunity)

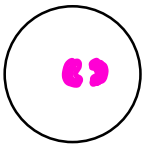
3) Endotoxin (LPS - Lipopolysaccharide)
   ↳ Septicemia, Shock

Clinical manifestation:

- Males: Urethritis + perianal abscess → purulent discharge - resembles "flow of seed" → water can perineum
- Females: cervicitis / vaginitis + perihepatic inflammation → Fitz Hugh Curtis Syndrome
- Neonates: Ophthalmia neonatorum

Δdis : 1) Microscopy :

Gram negative cocci arranged in pairs

 - kidney shaped

2) Culture : Selective media : Thayer Martin fermentation

Selectively favors growth of *Neisseria* by inhibiting growth of gram ⊕ organisms with vancomycin, gram ⊖ organisms except *Neisseria* with trimethoprim and colistin, and fungi with nystatin

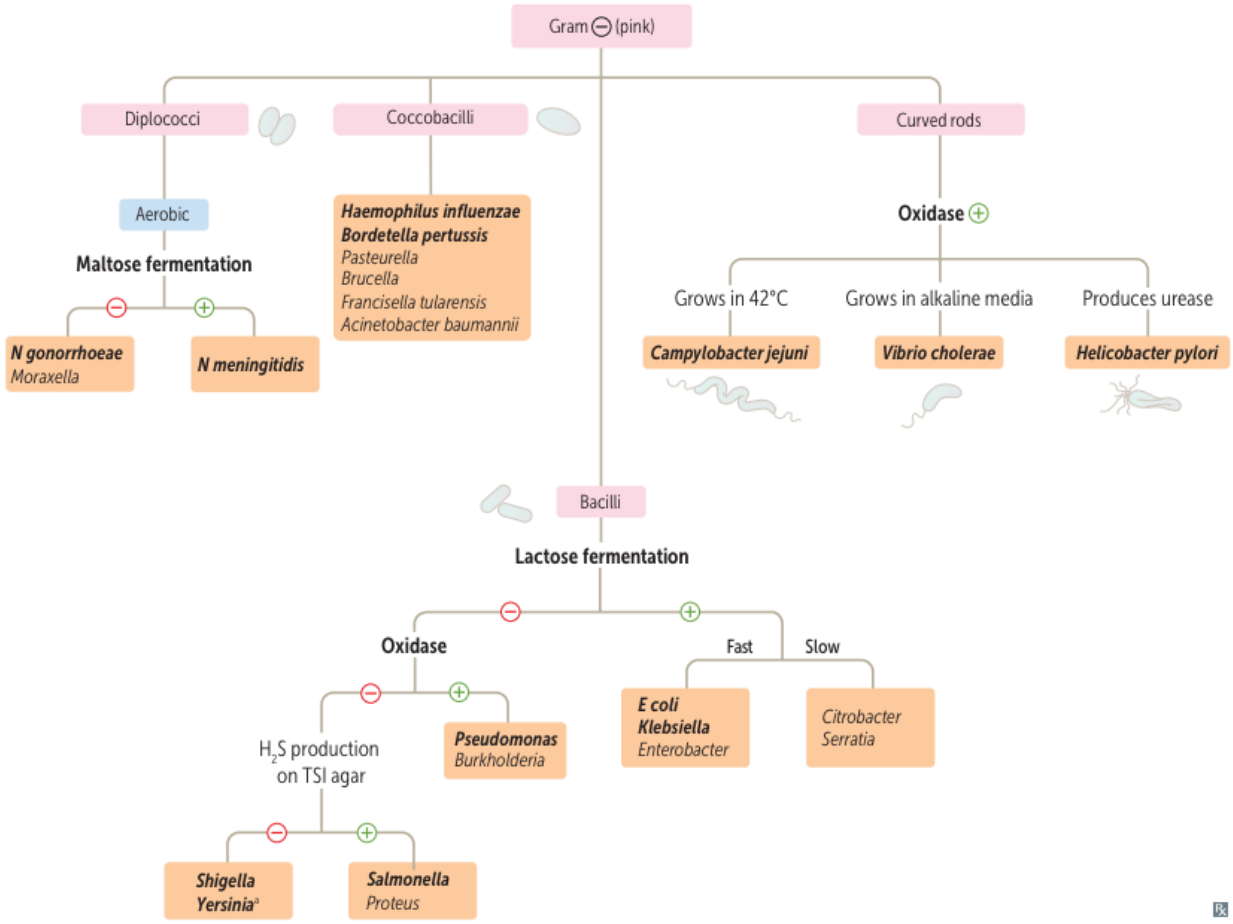
Modified New York medium

3) Identification : Maltose Non fermentation

Rx : Ceftriaxone + Azithromycin / Doxycycline

↓ allergic / resistant

Spectinomycin


Gram ⊖ (pink)
Diplococci
Coccobacilli
Curved rods
Aerobic
Maltose fermentation
⊖
⊕
N gonorrhoeae
Moraxella
N meningitidis
Haemophilus influenzae
Bordetella pertussis
Pasteurella
Brucella
Francisella tularensis
Acinetobacter baumannii
Oxidase ⊕
Grows in 42°C
Grows in alkaline media
Produces urease
Campylobacter jejuni
Vibrio cholerae
Helicobacter pylori
Bacilli
Lactose fermentation
⊖
⊕
Oxidase
Fast
Slow
⊖
⊕
H2S production on TSI agar
Pseudomonas
Burkholderia
E coli
Klebsiella
Enterobacter
Citrobacter
Serratia
⊖
⊕
Shigella
Yersinia[a]
Salmonella
Proteus