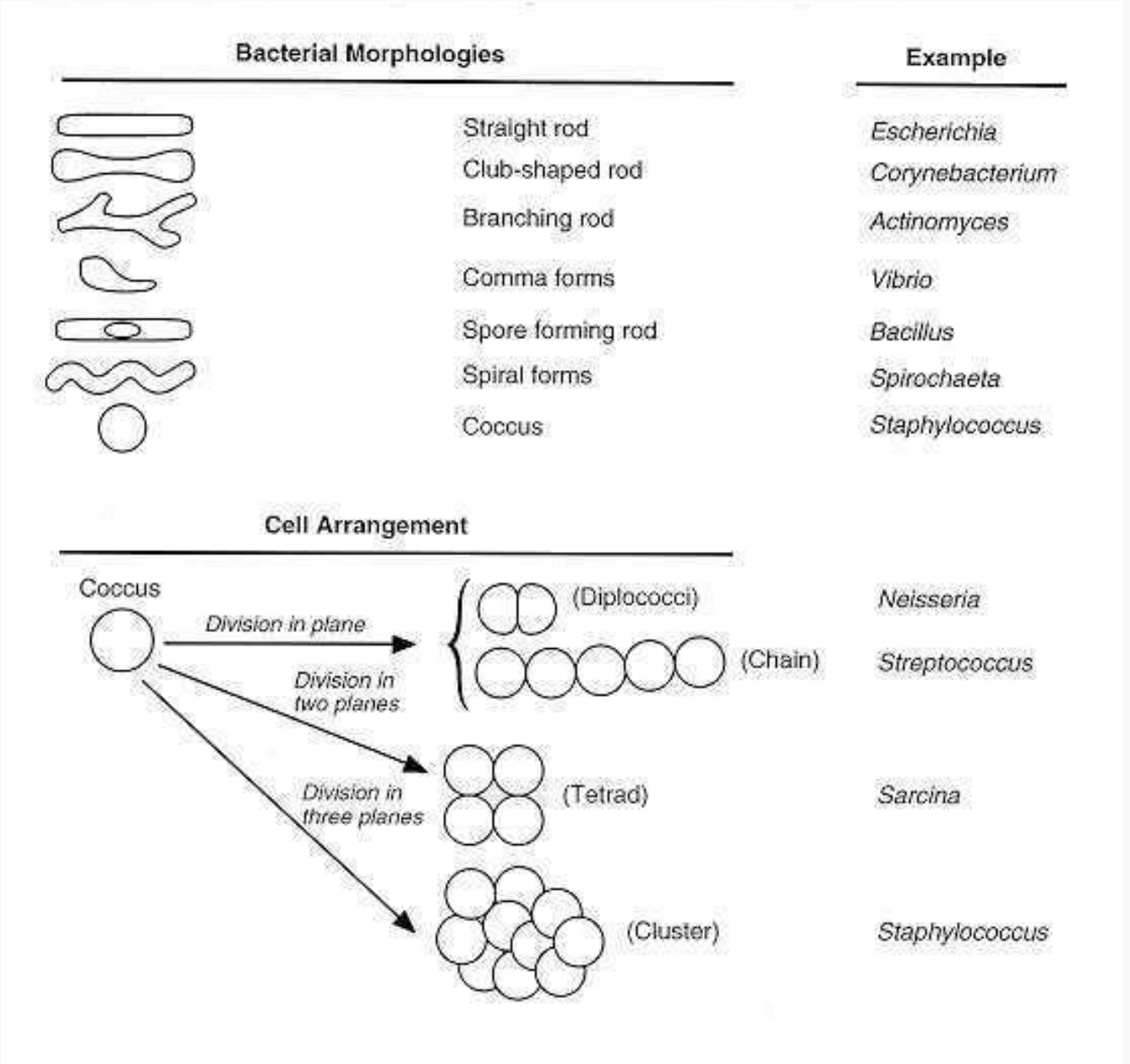
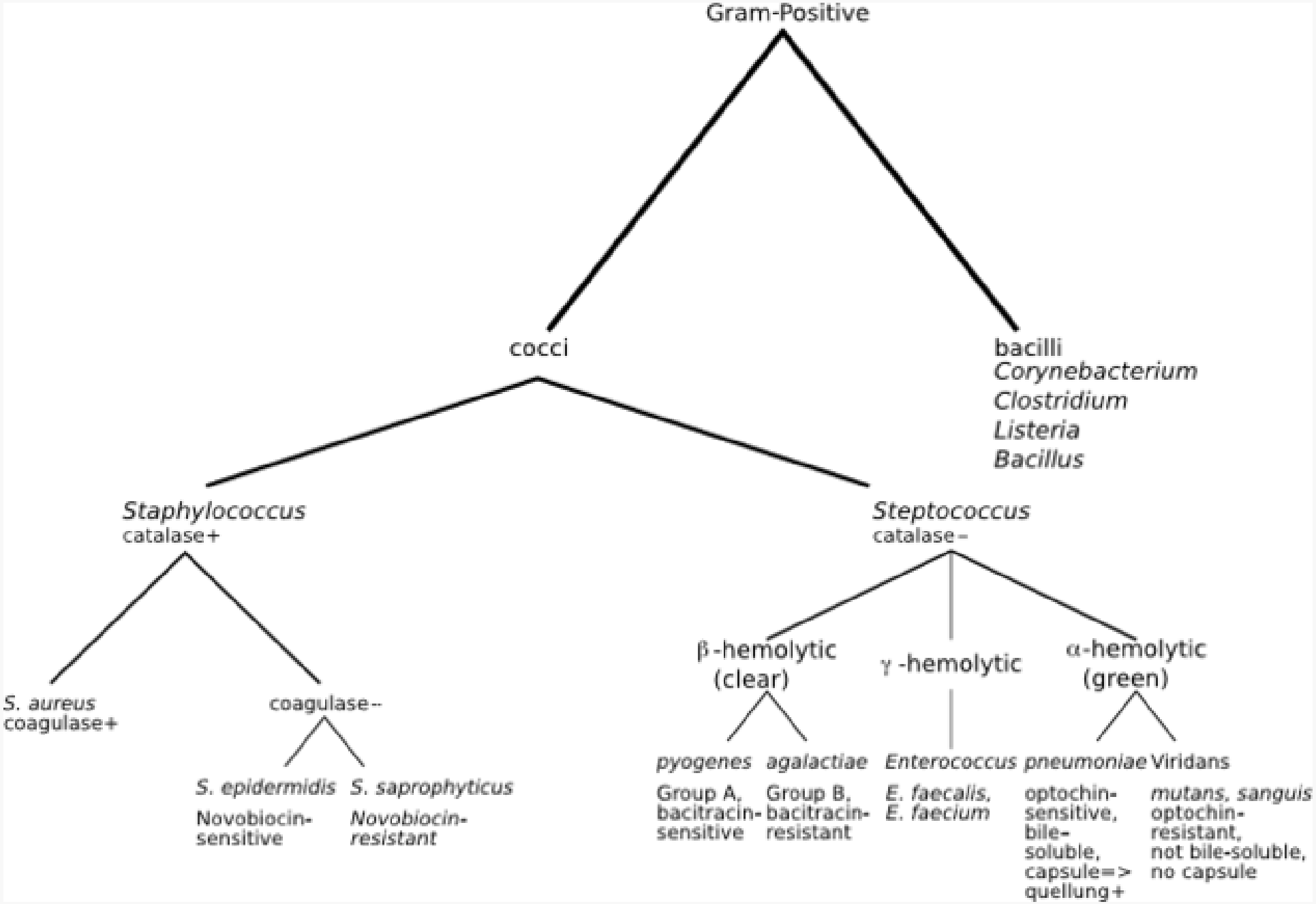
# Respiratory Tract Infection

Microbiology Approach

# Overview

- Organisms
- Pathogenesis
- Laboratory iagnosis
- Type of infections
- Self-assessment: questions


Bacterial Morphologies
Example
Straight rod
Escherichia
Club-shaped rod
Corynebacterium
Branching rod
Actinomyces
Comma forms
Vibrio
Spore forming rod
Bacillus
Spiral forms
Spirochaeta
Coccus
Staphylococcus
Cell Arrangement
Coccus
Division in plane
Division in two planes
Division in three planes
(Diplococci)
(Chain)
(Tetrad)
(Cluster)
Neisseria
Streptococcus
Sarcina
Staphylococcus

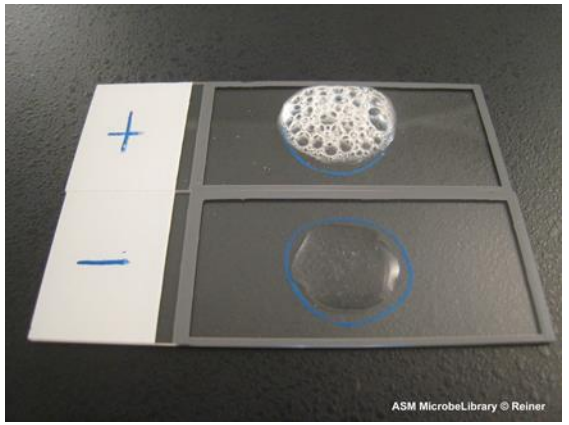

Gram-Positive
cocci
bacilli
Corynebacterium
Clostridium
Listeria
Bacillus
Staphylococcus
catalase+
Steptococcus
catalase–
S. aureus
coagulase+
coagulase–
S. epidermidis
Novobiocin-sensitive
S. saprophyticus
Novobiocin-resistant
β-hemolytic (clear)
γ-hemolytic
α-hemolytic (green)
pyogenes
Group A, bacitracin-sensitive
agalactiae
Group B, bacitracin-resistant
Enterococcus
E. faecalis, E. faecium
pneumoniae
optochin-sensitive, bile-soluble, capsule=> quellung+
Viridans
mutans, sanguis
optochin-resistant, not bile-soluble, no capsule

# GRAM POSITIVE COCCI

2

**Catalase**

- Positive → Staphylococcus
  - **Coagulase**
    - Positive → *S aureus*
    - Negative → **Novobicin**
      - Sensitive → *S epidermidis*
      - Resistant → *S saprophyticus*
- Negative → Streptococcus
  - **Haemolysis**
    - **Beta** → **Bacitracin**
      - Sensitive → ***S pyogenes***
      - Resistant → ***S agalactiae*** (most group C, G)
    - **Alpha (or gamma)**
      - **Optochin**
        - Sensitive → ***S pneumoniae***
        - Resistant → **Viridans group**
      - **Bile esculin**
        - Positive → **6.5% NaCl growth**
          - Positive → Enterococcus
          - Negative → *S bovis* (group D)
        - Negative → **Nutrionally variant streptococcus**
          - **Growth in tellurite**
            - Positive → *E faecalis*
            - Negative → *E faecium*

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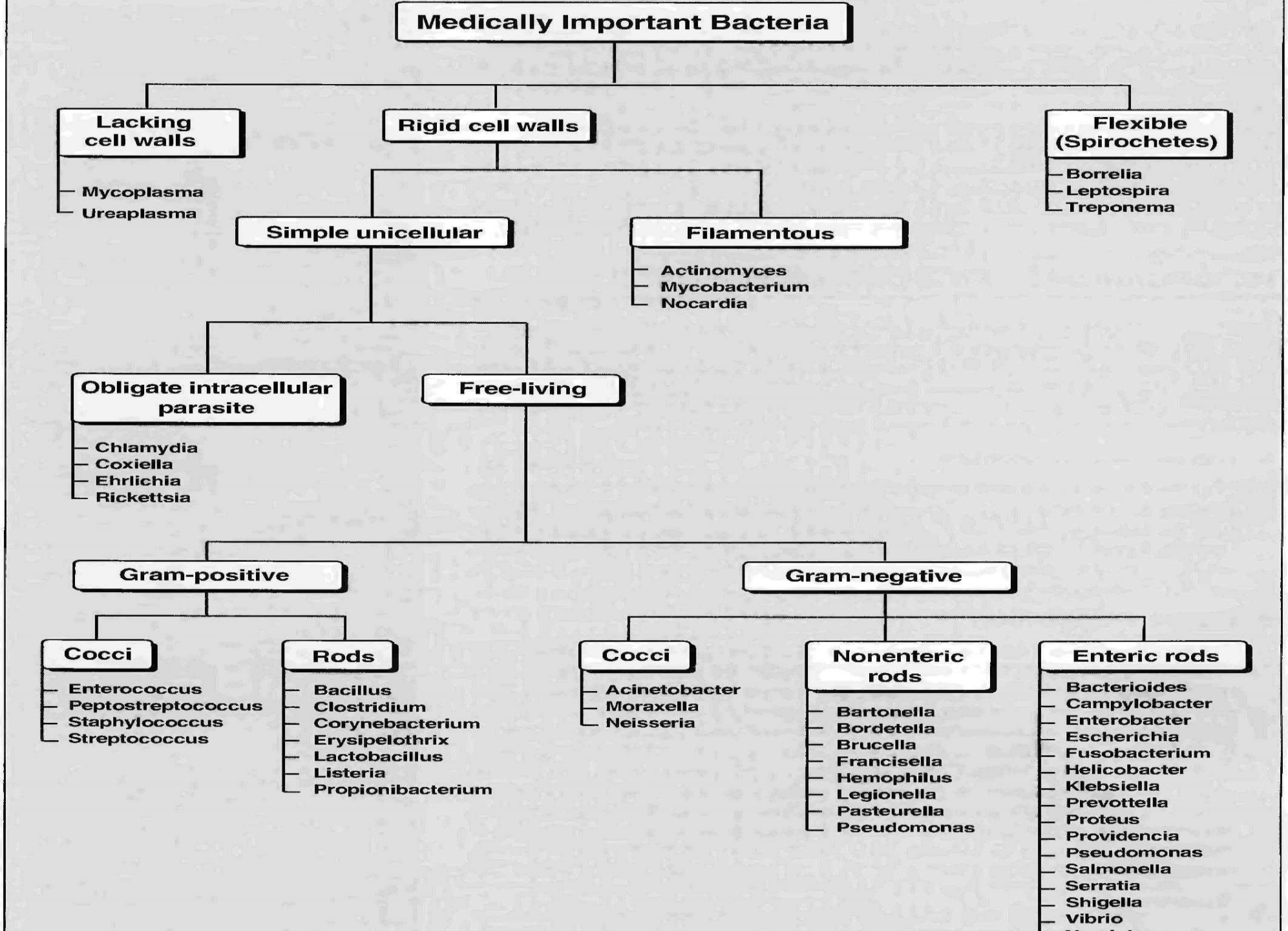

Medically Important Bacteria
Lacking cell walls
Mycoplasma
Ureaplasma
Rigid cell walls
Flexible (Spirochetes)
Borrelia
Leptospira
Treponema
Simple unicellular
Filamentous
Actinomyces
Mycobacterium
Nocardia
Obligate intracellular parasite
Chlamydia
Coxiella
Ehrlichia
Rickettsia
Free-living
Gram-positive
Gram-negative
Cocci
Enterococcus
Peptostreptococcus
Staphylococcus
Streptococcus
Rods
Bacillus
Clostridium
Corynebacterium
Erysipelothrix
Lactobacillus
Listeria
Propionibacterium
Cocci
Acinetobacter
Moraxella
Neisseria
Nonenteric rods
Bartonella
Bordetella
Brucella
Francisella
Hemophilus
Legionella
Pasteurella
Pseudomonas
Enteric rods
Bacterioides
Campylobacter
Enterobacter
Escherichia
Fusobacterium
Helicobacter
Klebsiella
Prevottella
Proteus
Providencia
Pseudomonas
Salmonella
Serratia
Shigella
Vibrio

# GRAM-POSITIVE COCCI

- *Streptococcus Group A*
- *Streptococcus pneumoniae*
- *Staphylococcus aureus*

# STREPTOCOCCI

Catalase – Negative
Gram-positive cocci in chai

# Streptococci

**I-Beta-hemolytic Streptococcus (Lancefield Groups)**

- Group A Streptococcus (Streptococcus Pyogenes)
- Group B Streptococcua (Streptococcus agalactiae)
- Group C Streptococcus

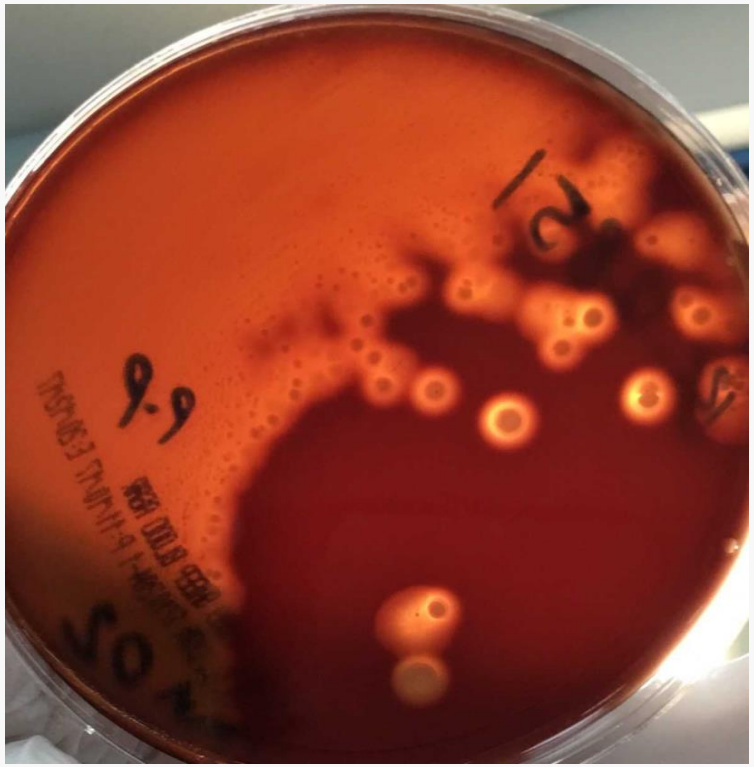
**II-Alpha-hemolytic Streptococcus**

- Streptococcus Pneumoniae (Pneumococcus)
- Viridans streptococcus (bacterial endocarditis)

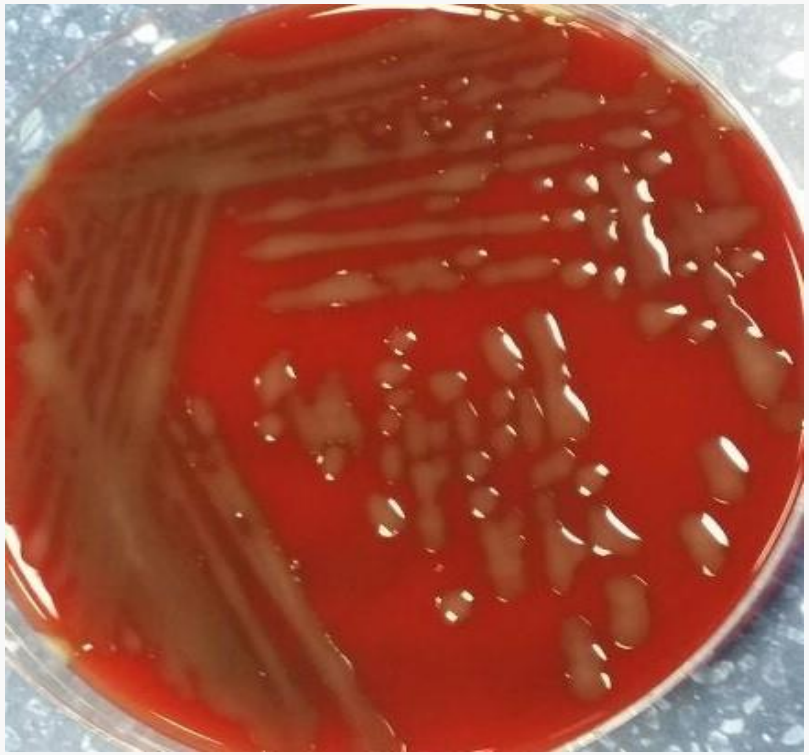
**III-Non-hemolytic Streptococcus**

- Enterococci
  - *Streptococcus faecalis*
  - *Streptococcus facium*

# Streptococci



β- hemolysis

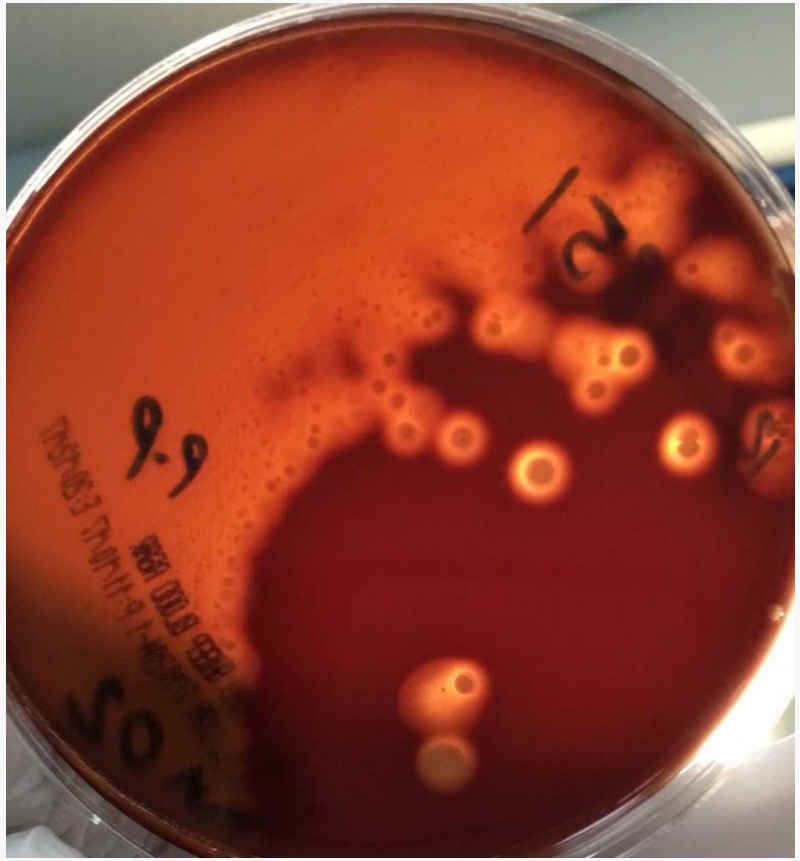


α-hemolysis

*У*-hemolysis

# Beta-hemolytic streptococci

## *Group A streptococci*



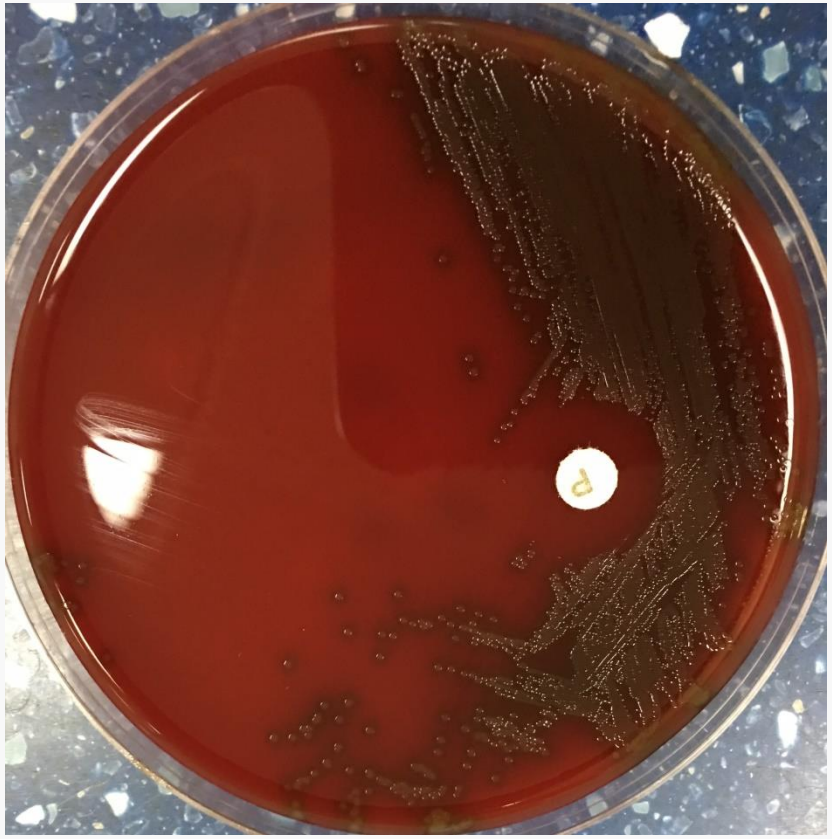
# Streptococcus group A (S. pyogen)

- Pharyngitis
- **Treatment**
- oral penicillin or erythromycin
- reduce the risk of major non-infective sequelae:
  - *as rheumatic heart disease*
  - *poststreptococcal glomerulonephritis*
  - *Sydenham's chorea*
  - scarlet fever
  - ***quinsy*** *(paratonsillar abscess)*
  - streptococcal toxic shock syndrome

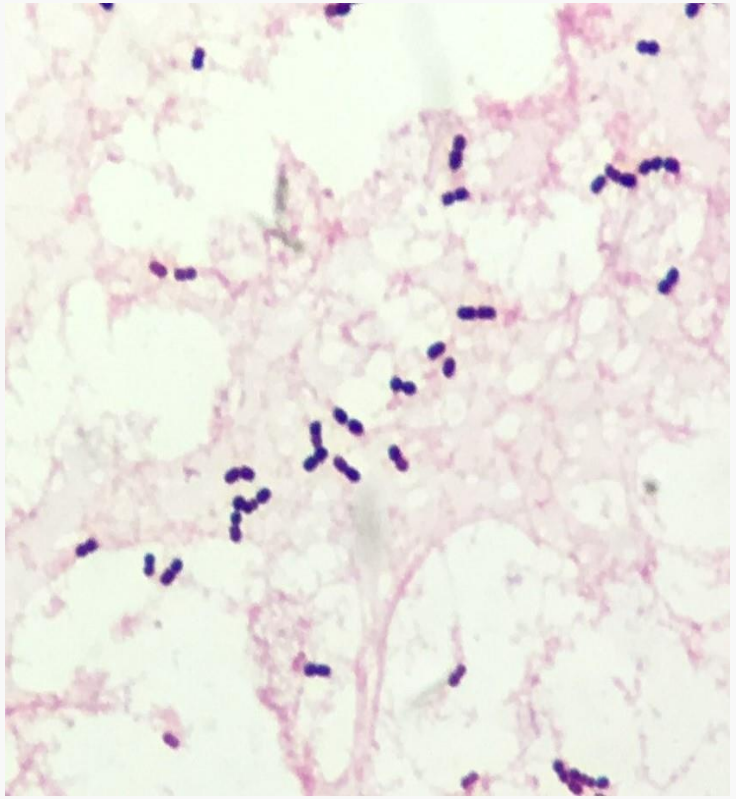
# Alpha-hemolytic streptococci

## - *Streptococcus pneumoniae*

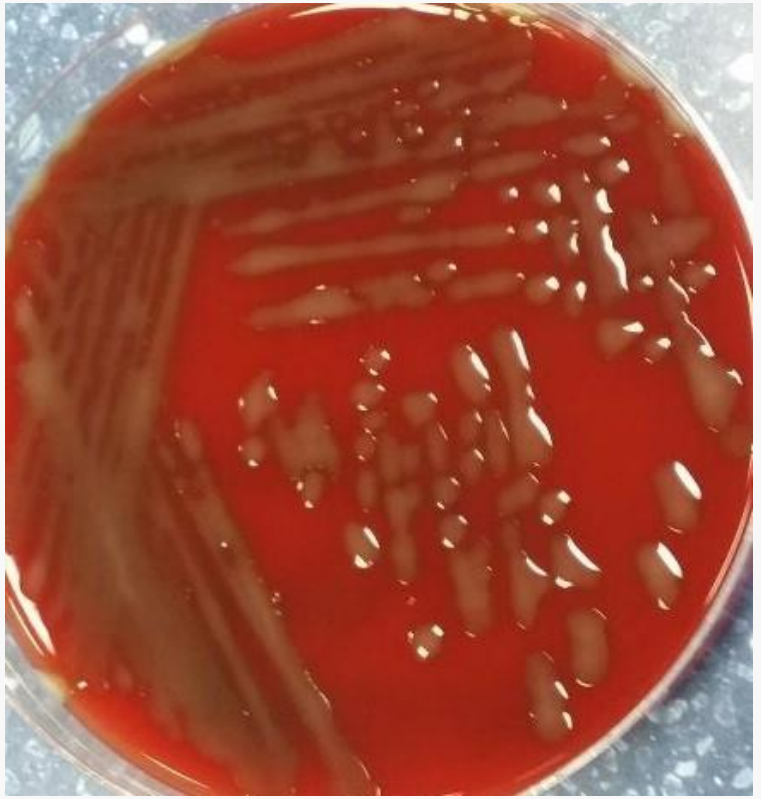
## - *Viridans streptococci*



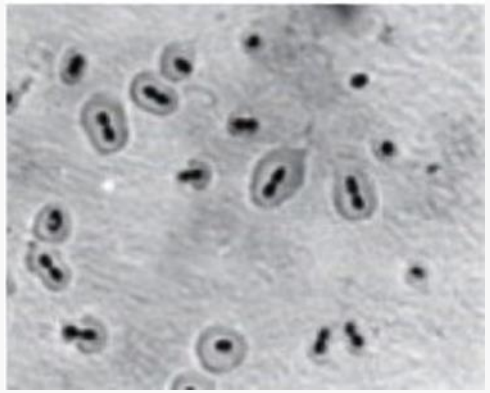
Optichin sensitive



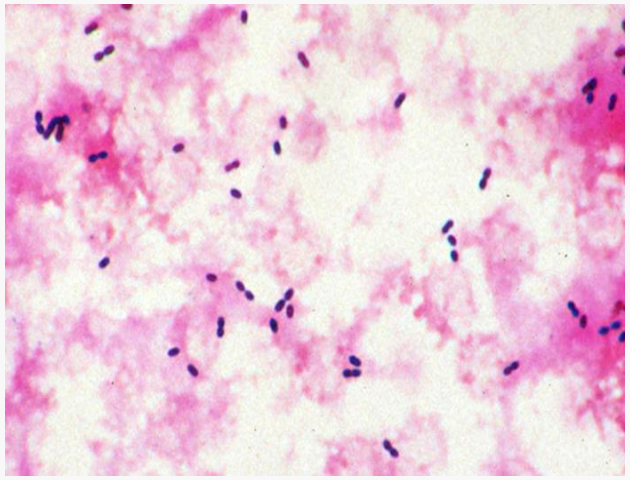
Gram-positive diplococci



# Alpha-hemolytic Streptococc (diplococci) (**Encapsulated**)



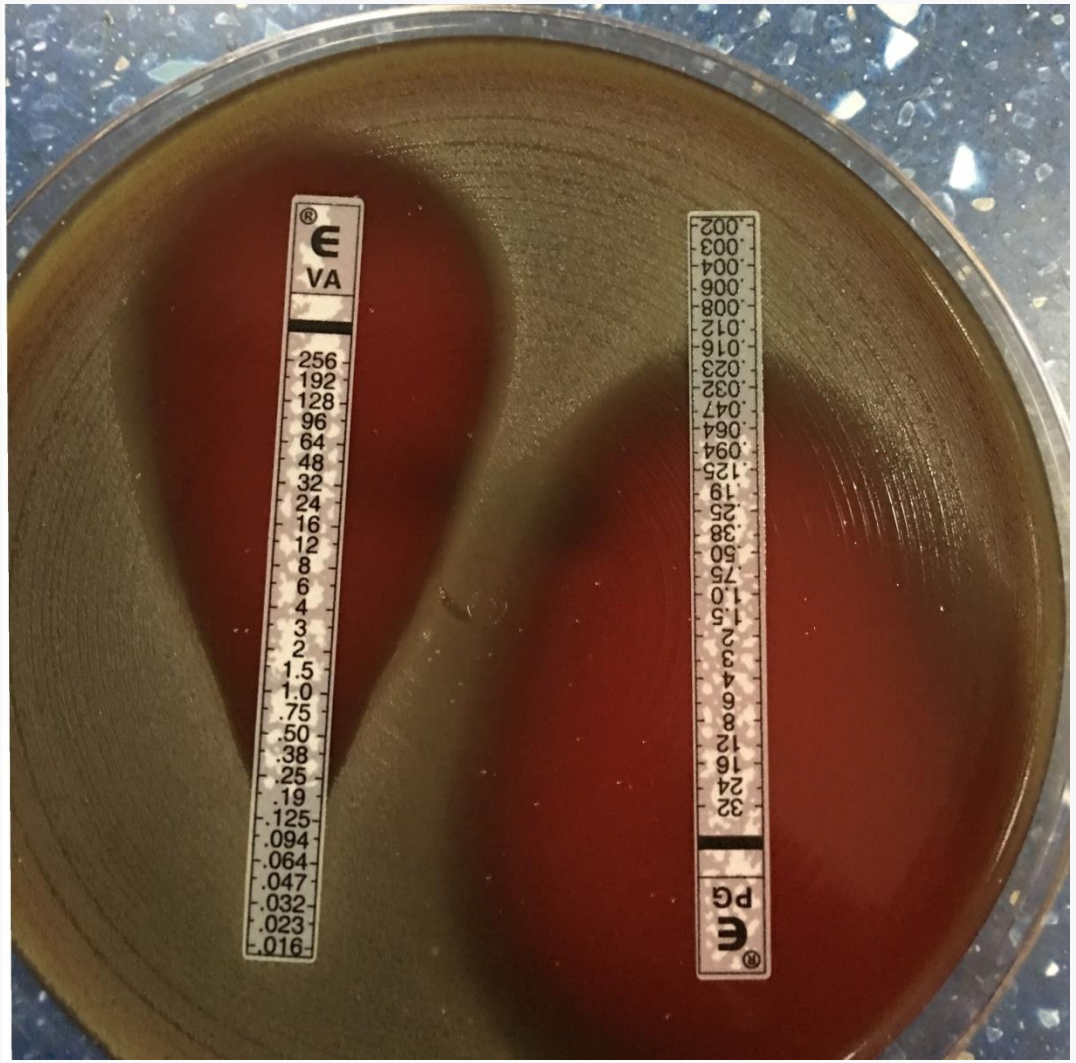
- ***Lab***
- WBC
- Gram stain
  - Gram positive encapsulated *diplococci*
  - Blood Culture (α hemolytic)
- Sputum culture
- ***Radiology***
- Chest X-ray
  - Lobar consolidation (often lower lobe)



# Streptococcus Pneumoniae (Pneumococcus)

- **Epidemiology**
  - *Most common cause of community acquired pneumonia*
- **Classic Symptoms**
  - *Shaking rigors*
  - *Fever*
  - *Purulent sputum*
  - *Pleuritic chest pain*
  - *Dyspnea*
  - *Chest splinting*

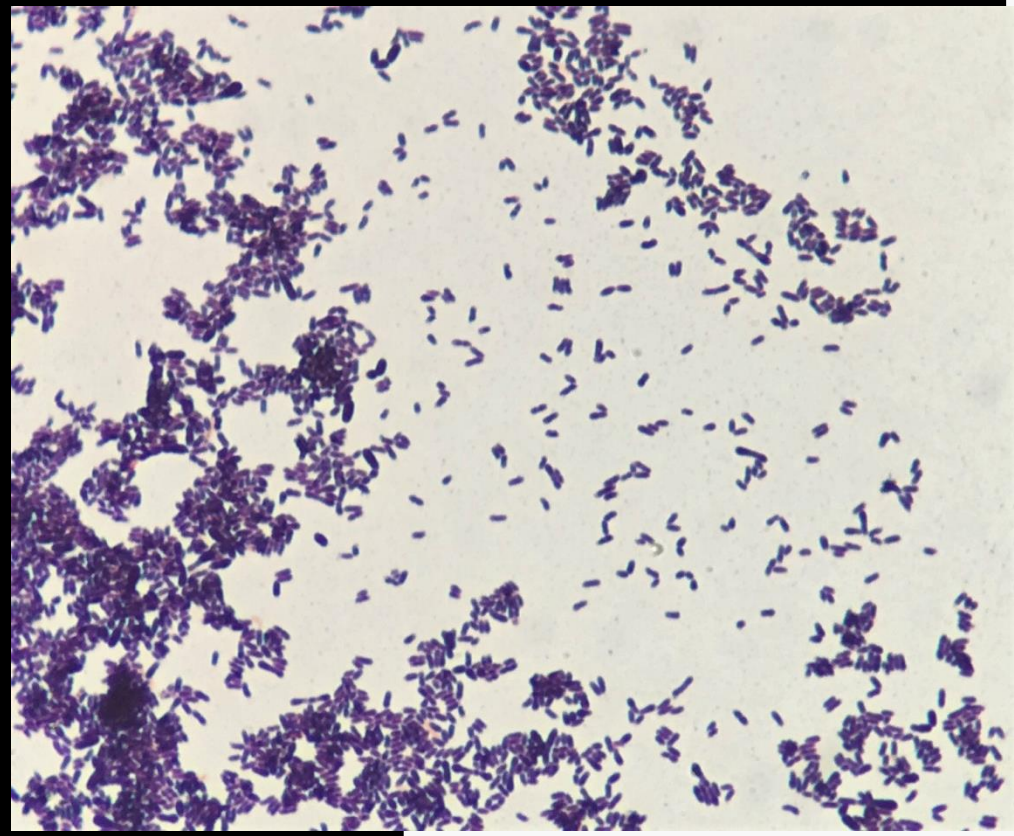
# E – test – *Streptococcus pneumoniae*



# Viridans streptococci
## - alph-hemolytic
## - optichin resistant

# Gram-positive bacilli

***Corynebacterium Diphtheriae***



# Diphtheria
# *Corynebacterium Diphtheriae*

## Epidemiology

- Rare (Immunization)
- **Epidemic**

**Symptoms**

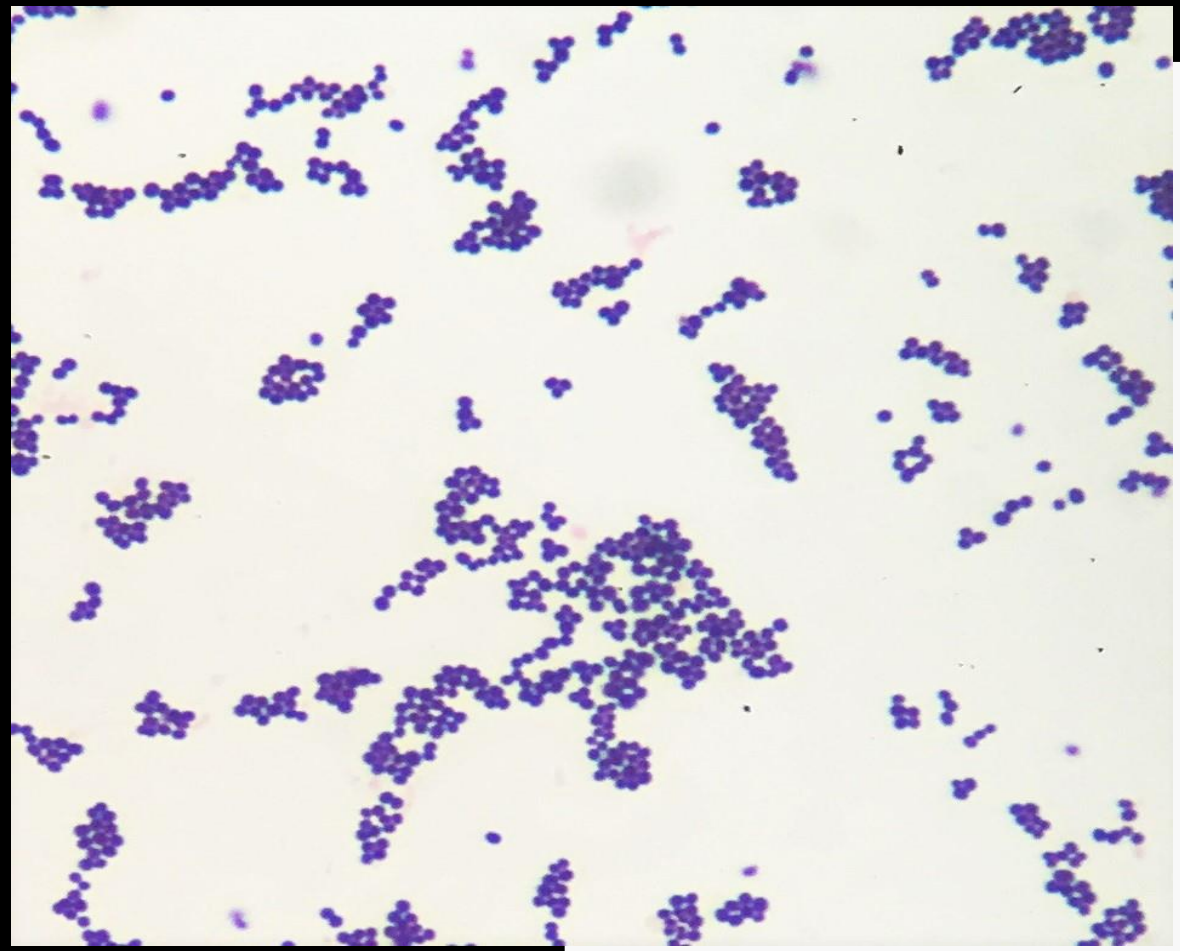
- sore throat
- dysphagia
- Weakness
- Malaise

- **Signs**
  - Toxic appearance
  - fever
  - Tachycardia
  - Pharyngeal erythema
    - Gray-white exudate *or pseudomembrane*
  - Cervical lymphadenopathy

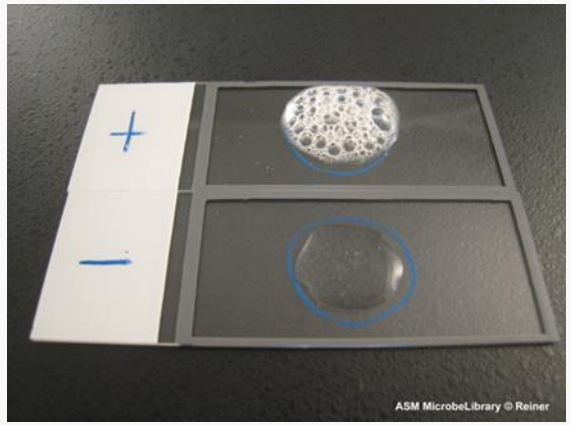
- **Management**
  - Diphtheria antitoxin
  - Penicillin
  - Erythromycin
- **Prevention**
  - DTP/DTaP vaccination

# Staphylococci

Catalase  positive
Gram-positive cocci
 in clusters



# Staphylococci




- Staphylococcus aureus
- Staphylococcus epidermidis

# Staphylococcus aureus

- Catalase +
- Coagulase +

- Normal flora
  - **Nose**
  - Skin
- Suppuration, **abscess**
- **Skin infections**
  - **Cellulitis**
  - Wound infection
- Septicemia
- **Endocarditis**
- Pneumonia
- Meningitis

- Staphylococci are **resistant** to:
- Penicillin and ampicillin
- **β-lactamase production**
- Oxacillin drug of choice
- **MRSA**

(Methicillin Resistant Staphylococcus Aureus).

# Management

- Increasing Penicillin Resistance
  - Penicillin (Sensitive)
  - Ampicillin IV or Amoxicillin PO
  - Erythromycin
  - Azithromycin
  - Clarithromycin
  - Oral second generation cephalosporin
  - Parenteral third generation cephalosporin

- High-Level Penicillin Resistance
  - Broad spectrum Fluoroquinolone
    - Levofloxacin
    - Gatifloxacin
    - Grepafloxacin
    - Moxifloxacin
    - Sparfloxacin
  - Parenteral third generation Cephalosporin
  - High dose Ampicillin
  - Vancomycin IV with or without Rifampin

# FASTIDIOUS GRAM NEGATIVE COCCOBACILLI

*Haemophilus influenzae*
*Bordetella Pertussis*
*Legionella pneumophila*

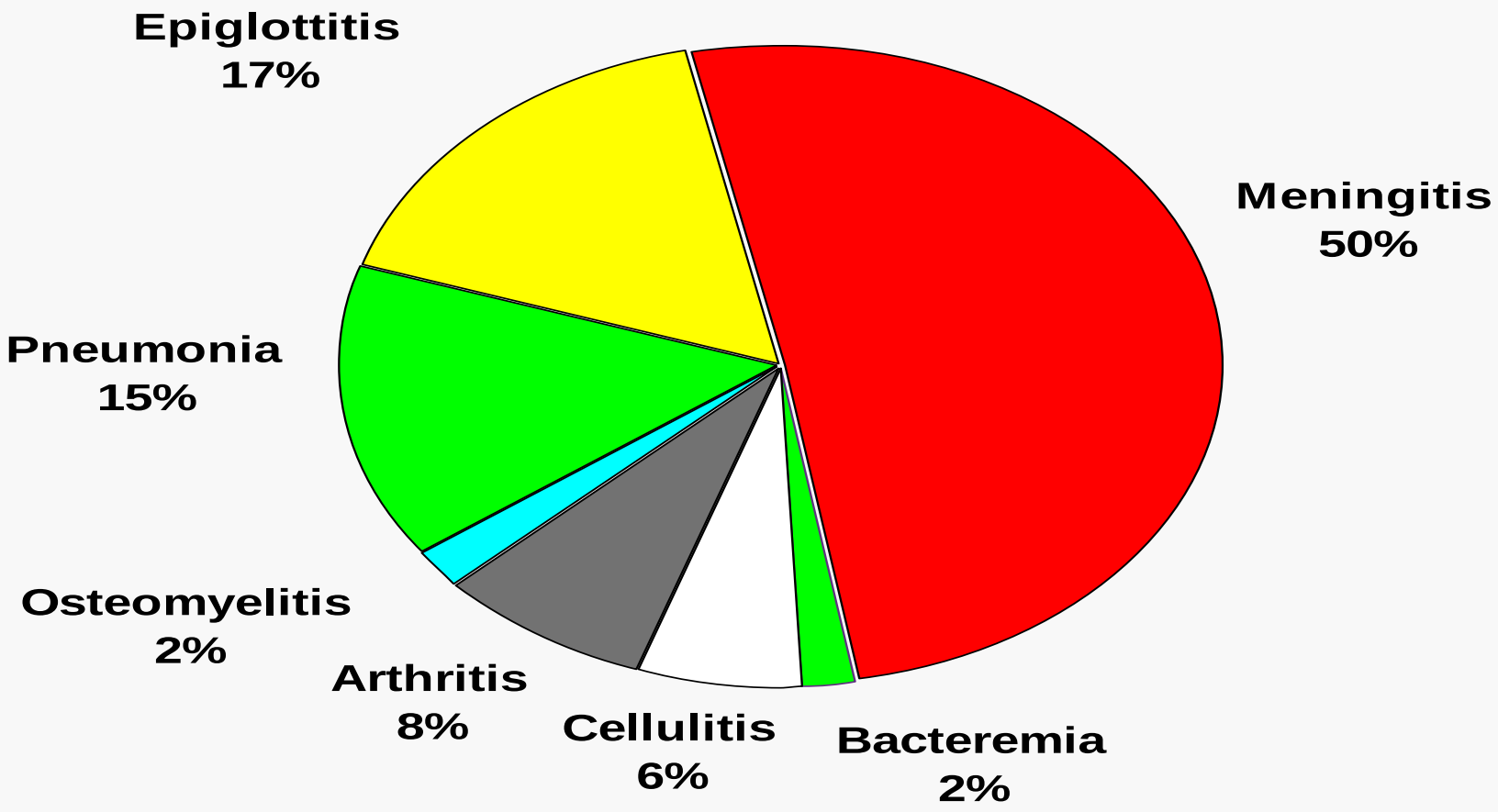
# *Haemophilus influenzae* type b

- Small aerobic gram-negative bacteria
- Polysaccharide capsule
  - Six different serotypes (a-f) of polysaccharide capsule
  - 95% of invasive disease caused by type b
  - Nontypeable (unencapsulated) strains cause ear infections in children and bronchitis in adults
- Severe bacterial infection, particularly among infants
- Growth requires accessory growth factors
  - "**X**" factor (hemin)
  - "**V**" factor (nicotinamide adenine dinucleotide [NAD]).

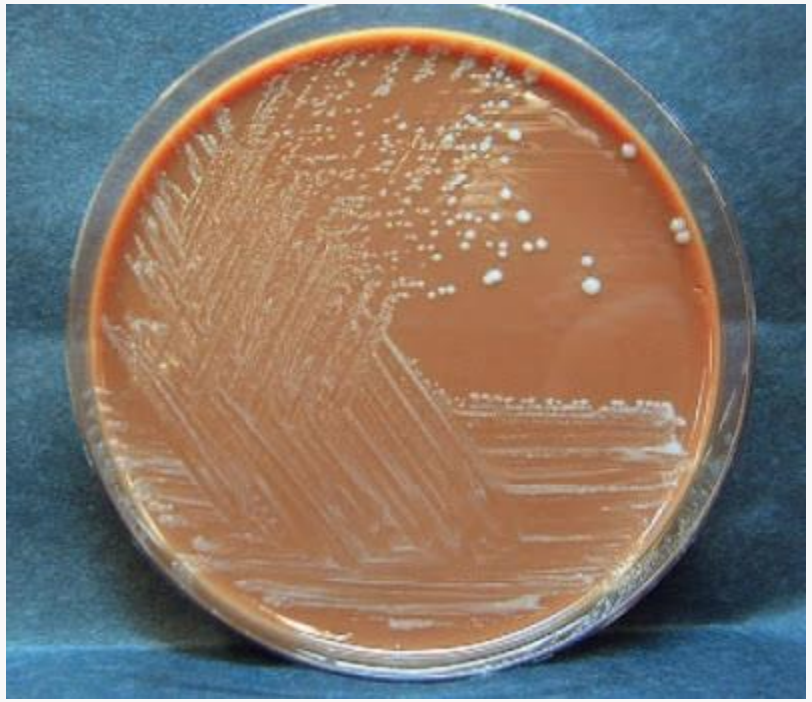
**Pathogenesis**

- Organism colonizes nasopharynx
- isolated from the nasopharynx of 0.5%–3% of normal infants and children but was not common in adults.
- not common beyond 5 years
- In some persons organism invades bloodstream and cause infection at distant site
- **Epiglottitis** is an infection and swelling of the epiglottis and may cause life-threatening airway obstruction.
- Ampicillin-resistant strains now common throughout the WORLD
- Hib vaccine
  - 3 conjugate vaccines licensed for use in infants as young as 6 weeks of age

# *Haemophilus influenzae* type b Clinical Features




*prevaccination era



# *Bordetella pertussis*
## Whooping Cough (Pertussis)

- Major cause of childhood fatality prior to vaccination
- Incubation period 4-21 days
- 3 Stages
  - *1st Stage- Catarrhal Stage 1-2 weeks*
  - *2nd Stage- Paroxysmal Stage 1-6 weeks*
  - *3rd Stage- Covalescent Stage weeks-months*
- Pertussis Vaccine
- *B. pertussis* is difficult to isolate
- most successful during the catarrhal stage and specimens should be collected from the posterior nasopharynx
- selective media Bordet-Gengou, or charcoal agar

## Transmission

- Very Contagious
- Transmission occurs via respiratory droplets
- Filamentous hemagglutinin
- Outbreaks first described in the 16th Century

# *Legionella pneumophila*
## Legionnaires' disease
## Pontiac fever

### Description

- aerobic, gram-negative
- important causes of
  - *community-acquired*
  - *nosocomial pneumonia*
- Bacteria ubiquitous in environment, typically water
- Intracellular

### Epidemiology

- Immunocompromised individuals are most susceptible
- Legionnaires' disease
  - *Hospitalization common*
  - *Case-fatality rate: 5-30%*

# Legionnaires' disease

- Loss of strength (asthenia)
- High fever
- Headache
- Nonproductive, dry cough
- Sometimes expectoration blood-streaked
- Chills
- Muscle pain
- Difficulty in breathing, chest pain
- Diarrhea (25–50% of cases)
- Vomiting, nausea (10–30% of cases)
- CNS manifestations
  - *Confusion*
  - *delirium (50% of cases)*
- Renal failure
- Hyponatraemia
- Lactate dehydrogenase levels >700 units/ml
- Failure to respond to beta-lactam antibiotics or aminoglycosides

# ***Legionella pneumophila***

## Transmission

- water containing legionellae,
- Inhalation of contaminated aerosol
- Cooling  towers
- Transmitted through aerosolization or aspiration of Legionella-contaminated water
- Humidifiers and respiratory therapy equipment

## Risk factors

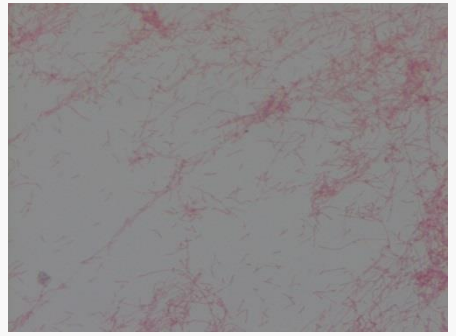
- Stay in accommodation designed for short stays (Hotels)
- **Travel**
- Age >40 years;
- male; heavy smoking,
- alcohol abuse; change in lifestyle
- Underlying disease such as
  - *Diabetes*
  - *Chronic heart disease*
  - *immunosuppression*

# *Legionella pneumophila*

## Diagnosis

- Gram stain of respiratory specimens with
  - *numerous neutrophils*
  - *no visible organisms*
- Urine antigen tests
- cultures of sputum
  - *buffered charcoal yeast extract (BCYE) agar*

## Treatment



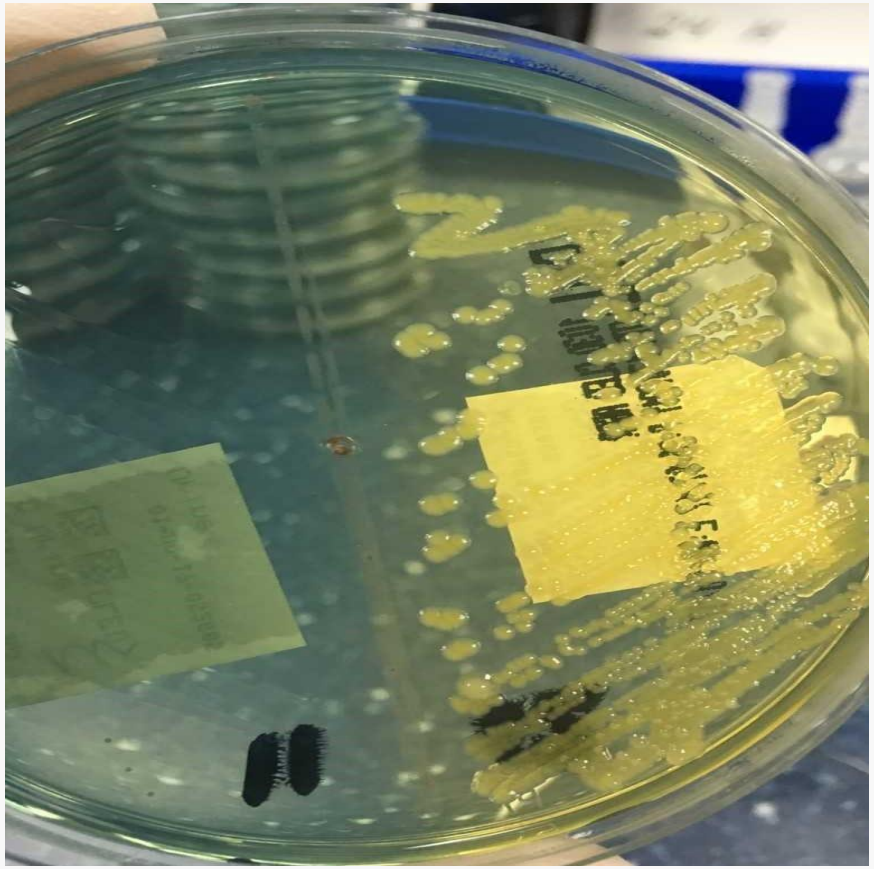
- Fluoroquinolone
- Azithromycin
- Beta-lactam antibiotics are not effective against Legionnaires' disease

# OXIDASE POSITIVE GRAM-NEGATIVE

Hospital acquired
Nosocomial

# *Pseudomonas aeruginosa*
# Nosocomial pathogen

- Cystic fibrosis
  - Exopolysaccharide (biofilm)
- Rx: combination of
  - penicillin +aminoglycoside
- Rapid develop resistance with a single drug therapy.
- Lipopolysaccharide



- Sepsis
- UTI
- Pneumonia
- Wound infection (burn)

# MYCOPLASMAS

Bacteria lacking a rigid cell

smallest known free-living organisms

# *M. pneumoniae*

## Eaton's agent

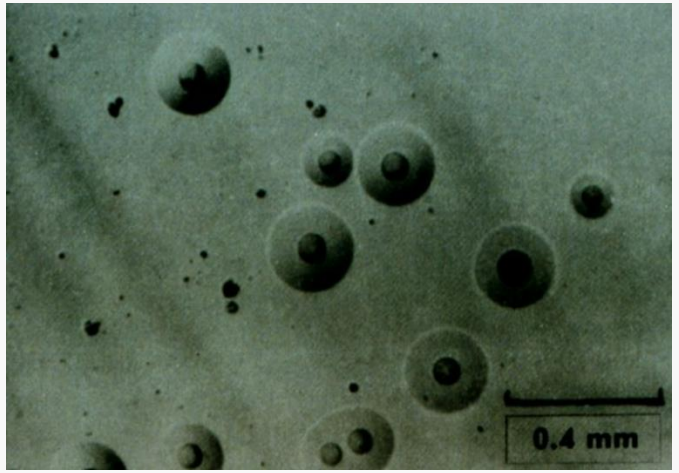
## Atypical pneumonia

- walking pneumonia" since symptoms tend to be milder than pneumonia caused by other bacteria
- The most common type of illness in children, is tracheobronchitis
- Atypical **pneumonia**

## Description

- Tiny pleomorphic cocci, short rods, short spirals, and sometimes as hollow ring forms.
- very small (0.2 x 0.8 um)
- Extracellular pathogen
- No Cell wall
  - *resistant to penicillins, cephalosporins, vancomycin*
  - *susceptible to tetracycline, erythromycin*
- Sterols present in the membrane
- Requires sterols for growth, can be grown on laboratory media

# Clinical Syndrome




## Clinical presentation

- **Pneumonia**
  - walking pneumonia frequently confused with virus infection
  - primary atypical
- **Tracheobronchitis**

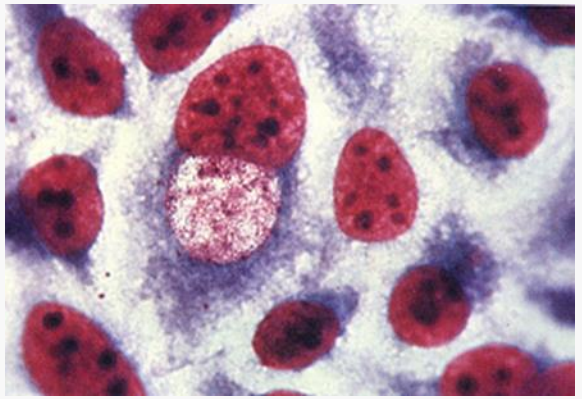
## Lab diagnosis

- **Culture:**
  - *fried egg colonies on medium containing sterols*
- **Serology:**
  - *Complement Fixation test, Hemagglutination*
  - *Cold agglutinins to human O erythrocytes*
- **PCR**

# OBLIGATE INTRACELLULAR PARASITES

## Chlamydia

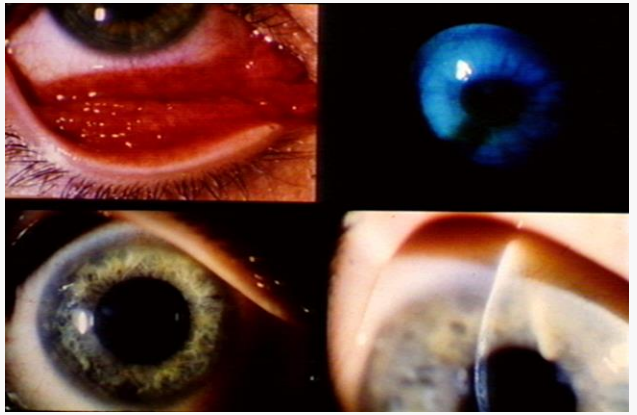
# Chlamydia



## Gram Negative

**Obligate Intracellular Parasites (no-peptidoglycan)**

- STD (Urethritis)
- Pneumonia
- Eye infection



# Pathogenesis

You should:

- Understand the mechanisms by which respiratory infections occur
- Know how pathogens overcome host defenses
- Understand what factors increase vulnerability to respiratory infections.

# Pathogenesis

- The principal function of the respiratory tract is gas exchange. It is therefore constantly exposed to particles, such as bacteria, viruses and spores
- Acquisition of microbial pathogens is primarily by
  - *Inhalation*
  - *aspiration*
  - *haematogenous spread*
- Factors that reduce the risk of microorganisms reaching the lower respiratory tract.
  - *nasal hairs*
  - *mucus covered surfaces in the posterior nasopharynx*
  - *The epiglottis, its closure reflex*
  - *cough reflex*
  - *the action of cilia*
- Antimicrobial factors present in respiratory secretions further disable inhaled microorganisms.
  - *Lysozyme*
  - *lactoferrine*
  - *secretory IgA.*
- Particles in the size range 5–10 μm may penetrate further into the lungs and reach the alveolar air spaces. Here, alveolar macrophages phagocytose pathogens, and neutrophils can be recruited via the inflammatory response.

# Pathogenesis

**Strategies to overcome host defences.**

- Influenza virus,
  - *has specific surface antigens that adhere to mucosal epithelial cells.*
  - *periodic genetic reassortment resulting in new adhesins to which the general population has no effective immunity.*
- *Streptococcus pneumoniae* and *Haemophilus influenzae*
  - *produce an enzyme (IgA protease)*
- Capsulated bacteria *Streptococcus pneumoniae* and *Haemophilus influenzae* and mycobacteria are:
  - **Resistant to phagocytosis**
- Human behaviour can also increase the risk of respiratory infection.
- Tobacco smoking has this effect by
  - *Reducing the efficiency of cilial function*
  - *Production of more viscous respiratory secretions.*
- Tracheal intubation
  - *in the critically ill*
  - *bypasses the upper respiratory tract and*
  - *provides a access for microbial access directly into the lungs.*

# Respiratory Tract Infection

Clinical Approach

# Overview

- Infections of structures that constitute the upper and lower respiratory tract.
- The general population commonly experiences upper respiratory tract infections, which are often seen in general practice.
- Lower respiratory tract infections are less common but are more likely to cause serious illness and death.
- Diagnosis and specific chemotherapy of respiratory tract infections present a particular challenge to both the clinician and the laboratory staff.
- Successful preventive strategies are available for several respiratory infections.

# Infectious diseases of the respiratory tract

- **Pharyngitis**
- **Common cold**
- **Influenza**
- **Otitis media**
- **Otitis externa**
- **Acute sinusitis**
- **Laryngitis**
- **Epiglottis**
- **Bronchitis**
- **Pneumonia**
  - community-acquired
  - hospital-acquired
- **Pulmonary tuberculosis**
- **In AIDS**

# Upper respiratory tract Infection URTI

## Pharyngitis

- inflammation of the throat, resulting in pain on swallowing and swollen, red pharyngeal mucosa.
- *constitutional symptoms (lethargy and malaise)*
- most often caused by a respiratory virus
  - Rhinovirus, coronavirus, adenovirus
  - Influenza virus, parainfluenza viruses, respiratory syncytial virus)
  - Epstein–Barr virus or coxsackievirus

- Etiological clues include:
  - ***conjunctivitis****: adenovirus*
  - ***tonsillar exudate:*** *Epstein–Barr virus*
  - ***posterior palatal ulcers:*** *coxsackievirus*
  - ***Streptococcus pyogenes (group A streptococcus)****: abrupt onset, pharyngeal lesions and beefy uvula*
  - ***Corynebacterium diphtheriae:*** *grey pharyngeal pseudomembrane in unvaccinated subject*

# Bacterial and Viral pharyngitis

**Bacterial pharyngitis**

- is less common
- Most frequent cause is ***S. pyogenes***
- Other rare bacterial causes
  - *Neisseria gonorrhoeae*
  - *Mycoplasma pneumoniae,*
  - *C. diphtheriae*
  - *Arcanobacterium haemolyticum.*
- Peak incidence is between autumn and spring in temperate climates, and during the rainy season in the tropics.
- Transmission is more rapid among groups sharing
- crowded living quarters and is by droplet spread or direct transmission

**Viral pharyngitis**

- is a self-limiting condition
- not usually require a specific etiological diagnosis.

# Most common pathogens implicated in lower respiratory tract infections

## Community-acquired pneumonia

- ***TYPICAL***
  - *Streptococcus pneumoniae*
  - *Haemophilus influenzae*
  - *Klebsiella species*
  - *Gram-negative bacilli*
  - *Staphylococcus aureus*
- ***ATYPICAL***
  - *Legionella species*
  - *Mycoplasma pneumoniae*
  - *Chlamydia species*
  - *Influenza virus*
  - *Other viruses*
  - *Mycobacterium tuberculosis*
  - *Moraxella catarrhalis*

## Hospital-acquired pneumonia

- **Gram-negative bacilli**
  - *Pseudomonas aeruginosa*
  - *Klebsiella pneumoniae*
  - *Acinetobacter*
  - *Legionella species*
- **Gram-positive cocci**
  - *Staphylococcus aureus*
  - *Streptococcus pneumoniae*

**Anaerobes**

**FUNGI**

# *Clinical features*

- Nasopharynx will result in a nasal discharge,
- Bronchitis in cough and sputum production
- Pneumonia in
  - *cough and sputum*
  - *increased respiratory rate*
  - *chest radiograph changes.*
- Most upper respiratory tract infections are caused by viruses and are self-limiting
- The role of the physician is limited to
  - *recognizing the more serious bacterial infections*
  - *Requirement of specific antimicrobial chemotherapy*
  - *extensive supportive treatment*
- Lower respiratory tract infection should always be taken seriously
  - *more likely to cause serious*
  - *morbidity or even death.*

## Risk Factors for Death in Patients with Community-Acquired Pneumonia

- ✓ Age > 50 years
- ✓ Male sex
- ✓ Residence in a nursing home
- ✓ Concurrent illness (neoplastic disease, congestive heart failure,
- ✓ cerebrovascular disease, renal disease, liver disease)
- ✓ Altered mental status
- ✓ Pulse  125/min
- ✓ Respiratory rate  30/min
- ✓ Systolic blood pressure < 90 mm Hg
- ✓ Temperature < 35°C or  40°C
- ✓ Blood urea nitrogen  11 mmol/L
- ✓ Glucose 14 mmol/L
- ✓ Hematocrit < 30%
- ✓ Sodium < 130 mmol/L
- ✓ Partial pressure of oxygen < 60 mm Hg
- ✓ Arterial pH < 7.35
- ✓ Pleural effusion

# Pneumonia: acute community-acquired

- Acute pneumonia has its onset either prior to or immediately after admission to hospital.
- one of the most common infectious causes of death worldwide.
- cough, chest signs and fever.
- cough may or may not be productive of purulent sputum.
- Chest signs are variable
  - *Consolidation*
  - *fluid in the air spaces*
  - *effusion or cavity.*

# Acute pneumonia

**Four main clinico-pathological patterns of acute pneumonia are recognized:**

**Lobar pneumonia**

- *pulmonary consolidation demarcated by border of segment or lobe*
- *most often caused by S. pneumoniae*
- *also caused by S. aureus, S. pyogenes (group A streptococcus) and Legionella pneumophila*

**Bronchopneumonia**

- *patchy consolidation around the larger airways*
- *caused by S. pneumoniae, H. influenzae, S. aureus and L. pneumophila*

**Interstitial pneumonia**

- *fine areas of interstitial infiltration in lung fields*
- *usually no sputum production at presentation*
- *caused by Legionella sp., Mycoplasma spp. or virus*
- *initial treatment is with erythromycin*

**Aspiration pneumonia**

- *follows aspiration of oral or gastric contents*
- *damage usually caused by chemical or mechanical insult*
- *chest X-ray changes either in lower right lobe or, if supine, apex of right lower lobe*
- *bacterial damage caused by oral streptococci or anaerobes.*

# Pneumonia: hospital-acquired
# Nosocomial pneumonia

- most common one to cause death.
- It affects smokers, patients with
- prior chest disease or following operations (especially thoracic and uppe abdominal)
- ventilated critically ill patients.
- mechanically ventilated patient is prone to colonisation of the lungs by bacteria from the stomach and mouth.
- most often caused by
  - *P. aeruginosa,*
  - *S. aureus*
  - *Enterobacteriaceae*
  - *Acinetobacter*
  - *Rarely Legionellas or respiratory viruses*

# Features of pneumonia caused by different bacteria

| Organism | Symptoms |
|---|---|
| ***Streptococcus pneumoniae*** | Sudden onset pleuritic pain, fever, rusty sputum, cold sores |
| ***Klebsiella pneumoniae*** | Thick, viscous red sputum, alcoholic patient |
| ***Staphylococcus aureus*** | Pneumonia following influenza |
| ***Streptococcus pneumoniae*** | Pneumonia in the chronic bronchitic |
| ***Haemophilus influenzae*** | Pneumonia in the chronic bronchitic |
| ***Mycoplasma pneumoniae*** | Non-productive cough, pharyngitis in young adult with family contacts; ambulant despite positive chest X ray |
| ***Legionella pneumophila*** | Non-productive cough, confusion, diarrhoea, middle-aged male, smoker, exposure to air conditioning or hotel shower |
| ***Mycobacterium tuberculosis*** | Upper lobe consolidation, hilar lymphadenopathy, vagrant or alcoholic |
| ***Chlamydia psittaci*** | Close contact with parrot or similar type of bird |

# Acute sinusitis

- Infection of the axillary, frontal, ethmoid or sphenoidal sinuses with bacteria from the nasopharynx as a result of a prior upper respiratory tract infection.
- The bacteria most commonly implicated are
  - *S. pneumoniae*
  - *H. influenzae.*
- Infection causes the sinus to fill up with mucopus, which alters the resonance of the voice and causes a feeling of local discomfort.

# Otitis externa

- Inflammation of the external auditory meatus is most often caused by the hyphae-forming fungus *Aspergillus niger*.
- A rare, sometimes life-threatening variant, called malignant otitis externa,
  - *occurs in diabetics*
  - *caused by Pseudomonas aeruginosa.*

# Diagnosis

**Learning objectives**

You should:

- know which features indicate that a specific area of the respiratory tract is infected
- know how to assess respiratory compromise
- know how to identify the pathogen.

# *Laboratory tests*

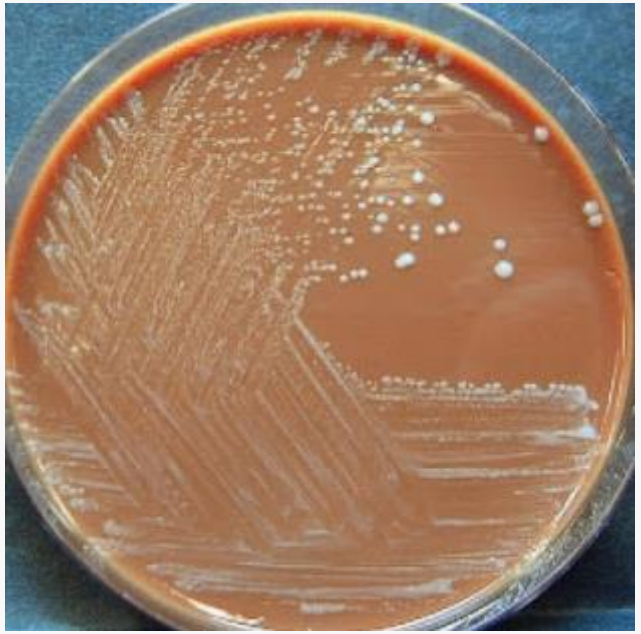
- the degree of respiratory compromise
- the identity of the causal pathogen
  - **History**
    - *tobacco consumption*
    - *recent travel,*
    - *occupation, pets*
    - *contacts with similar symptoms*
  - **physical examination**
  - **X-rays and laboratory investigations**
  - Blood gas analysis
- key indicators of disease severity in pneumonia are
  - *raised respiratory rate (> 30 beats/min),*
  - *hypoxia, hypercapnia,*
  - *bilateral or recently enlarging radiographic opacities,*
  - *shock, renal failure and confusion*

# CASE STUDIES

Clinical cases

# Case 1

A 3-year-old previously healthy boy complains of fever, irritability, right ear pain and ear discharge. His symptoms started before two days. A bulging tympanic membrane was observed. His rectal temperature was 39.5°C. Last week, he suffered from a mild upper respiratory tract infection (URTI) which he caught from daycare. He has not had any diarrhea, or vomiting. The only relevant point on past history is a previous AOM at the age of one which was treated for ten days with an unknown antibiotic. He has no allergies or craniofacial abnormalities. Culture of ear discharge grew Gram-negative coccobacilli only on chocolate agar. The organism required both X and V factor to grow.



- **What is the diagnosis ?**

Acute otitis media

- **What are he most common bacteria causing AOM ?**

*Streptococcus pneumonae*
*Haemophilus influenzae*
*Group A streptococcus*

- **What is the most likely organism ?**

Herophilus influenzae

- **How do you manage the case ?**

Amoxicillin is the first line antibiotic for AOM because it covers the dominant pathogen Streptococcus pneumoniae, in addition to Group A strep. Given that most invasive infections are due to streptococcus, amoxicillin is the ideal first line antibiotic.

# Case 2

A 45-year-old male with a known history of asthma presented at the Emergency Room with a 1-day history of fevers, shaking chills, and productive cough. He stated that he was coughing up blood-tinged sputum that had a rusty appearance. The patient also remarked that he had some left-sided chest pain that was worse when he breathed in or coughed (pleuritic pain) and some dyspnea (shortness of breath). He denied any significant past medical history and was not taking any medications. He reported a history of smoking one pack per day. On physical exam he was a well-developed male in moderate distress. His temperature was 40 $^{0}$C, pulse 110 beats per minute, blood pressure 140/80 mmHg, respiratory rate 24, and O2 saturation 90% on room air. His lung examination revealed decreased breath sounds and dullness to percussion in the left lower lung base. Laboratory findings: WBC 18 000, 80% PMNs, 10% bands, 10% lymphocytes. A sputum sample and blood were collected, and a chest X-ray showed lobar pneumonia **Figure 1**. Blood cultures at 24 hours revealed gram positive diplococci.

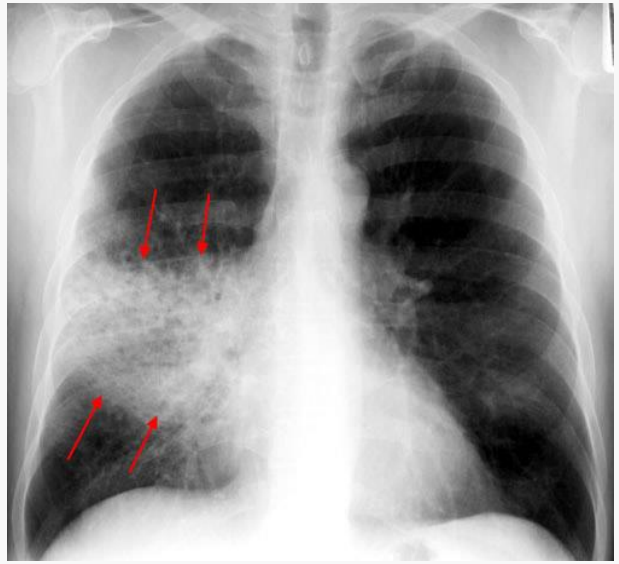
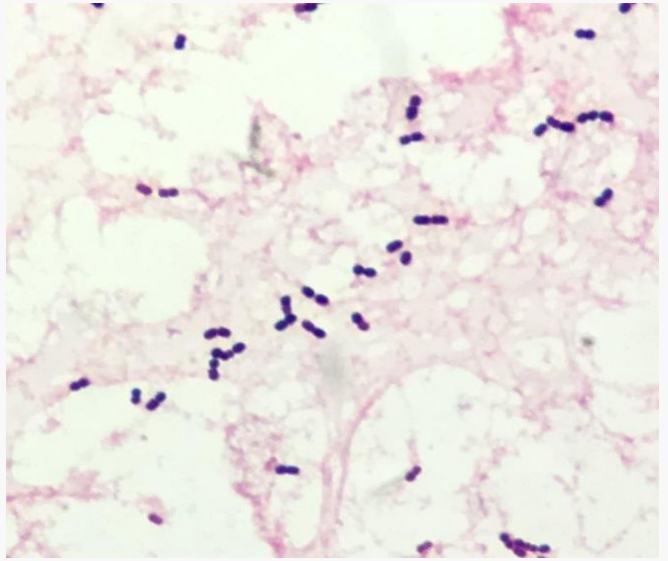


**Figure 1.** Chest X-ray: dense consolidation in the left lower lobe.



(**Figure 2.** Sputum Gram stain: gram-positive, bullet-shaped diplococci and inflammatory cells (

- What is the diagnosis ?

Lobar pneumonia

- What is the most likely organism ?

*Streptococcus pneumoniae*

- What is th management ?

# Case 3

A 7-year-old boy was well until yesterday when he developed dysphagia, painful anterior lymph nodes, and a fever to 40∞C. The patient vomited once and complained of a headache. Physical examination showed an acutely ill patient with a temperature of 39∞C and a pulse of 104 beats per minute. Examination of his head, eyes, ear, nose, and throat revealed bilateral tonsillar hypertrophy with grayish-white exudates and punctate hemorrhages (**Figure 1**). Bilateral tender submandibular lymph nodes were palpated. A throat swab was obtained. Laboratory findings were: hemoglobin, normal; hematocrit, normal; WBC count, 19 000 mm3; differential, 80% PMN, 4% bands, 15% lymphocytes. Throat swab culture on blood agar grew beta-hemolytic gram positive cocci.

**Figure 1**. Pharynx of the patient showing punctate hemorrhages and inflamed tonsils caused by b-hemolytic Streptococcus

**figure 3.** B hemolytic streptococci on blood agar plate.

**figure 3.** gram-positive cocci in chain

**1. What is the causative agent, how does it enter the body and how does it spread a) within the body and b) from person to person?**
**2. What is the host response to the infection and what is the disease pathogenesis?**
**3. What is the typical clinical presentation and what complications can occur?**
**4. How is the disease diagnosed and what is the differential diagnosis?**
**5. How is the disease managed and prevented?**

# Case 4

A 2-month-old child presented to a doctor with a 2-day history of a febrile upper respiratory tract infection. His clinical condition deteriorated with worsening cough and dyspnea, necessitating admission to hospital. On clinical examination in the hospital emergency department the child had obvious evidence of respiratory distress with severe intercostal retraction and tachypnea (>70 breaths per minute) together with tachycardia. On auscultation of the chest diffuse high pitched wheezing was audible and there were fine inspiratory crackles. Oxygen saturation of 92 % Radiologic investigation revealed findings typical of bronchiolitis, with hyperinflation of both lung fields (**Figure 1**). A diagnosis of acute bronchiolitis was made, and the child was admitted to hospital for further management. A respiratory virus was detected in nasal secretions (**Figure 2**); the child was nursed in isolation on oxygen therapy and made an uneventful recovery.

**Figure 1.** chest x ray Acute bronchiolitis. Early radiographic appearance – flat diaphragm and hyperlucent lung fields indicate hyperflation.

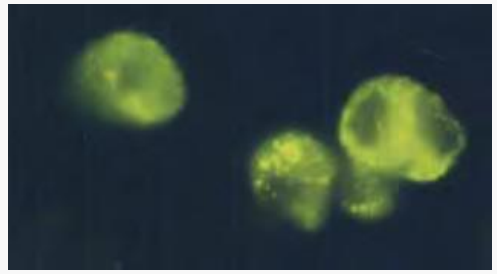


Figure 2. Photomicrograph of respiratory epithelial cells taken from a child infected with a virus and stained with a monoclonal antibody specific for respiratory syncytial virus.

**What is the causative agent, how does it enter the body and how does it spread a) within the body and b) from person to person?**

**Respiratory syncytial virus.**

**What is the host response to the infection and what is thedisease pathogenesis?**

**What is the typical clinical presentation and what complications can occur?**

**How is this disease diagnosed and what is the differential diagnosis?**

**How is the disease managed and prevented?**

# Case 5

A 63-year-old diabetic male presented to the emergency room accompanied with his son. He had been feeling weak, had lost weight, and often had a fever at night. One month ago, he started coughing up blood and feeling breathless, which had really worried him. He went to the physician on duty, who found that the patient had a low-grade fever and detected bronchial breathing when he listened to his chest. The doctor sent him for a chest X-ray and asked him to return for the results. When the X-ray result came back, it showed that he had apical shadowing and large cavitation consistent with chronic infection. The X-ray is shown in **Figure 1**. A sputum sample was taken for Ziehl-Neelsen stain **Figure 2.**

**Figure 1.** Chest X-ray of patient showing typical apical consolidation with possible cavities. There is also some consolidation adjacent to the mediastinum on the right. The bases are relatively spared.

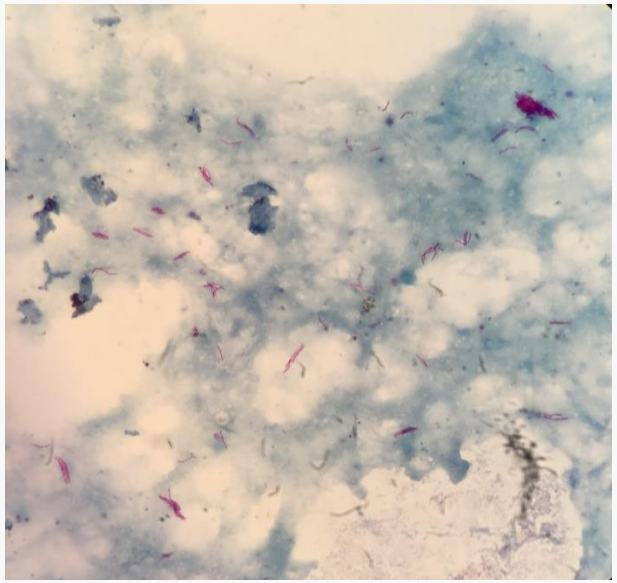


**Figure 2**. Ziehl-Neelsen stain of sputum: note the red bacilli (arrowed) against a green background stai

1. **What is the causative agent, how does it enter the body and how does it spread a) within the body and b) from person to person?**

**Mycobacterium tuberculosis**

1. **What is the definitive diagnostic test ?**

**Culture**

1. **What is the management ?**


**Figure 3.** Growth of Mycobacterium tuberculosis on Lowenstein Jensen medium.

# Case 6

A 12-year-old boy with no significant past medical history presented initially with a history of fever, dry cough and shortness of breath for 10 days. A CXR showed infiltration of the left lung (**Figure 1**). He was diagnosed with atypical pneumonia and given oral Clarithromycin (500 mg, every 8 h) which improved his symptoms. On day 4 of antibiotic treatment, the patient complained of mild eye itching, lid swelling with marked erythema in both eyes and whitish eye discharge. He also developed bullae inside the mouth and small pruritic lesions on both palms. Upon examination, he appeared healthy with no respiratory distress or fever (36.5 $^{0}$C, axillary). His respiratory rate was 24 breaths/min, his blood pressure was 115/70 mmHg, and his SpO2 was 97%. A mouth examination showed severe oral mucositis with haemorrhagic vesiculobullous eruptions over the buccal mucosa. An eye examination revealed bilateral conjunctival ingestion and pseudomembrane formation (Figure 3). Serology for IgM and PCR were positive.

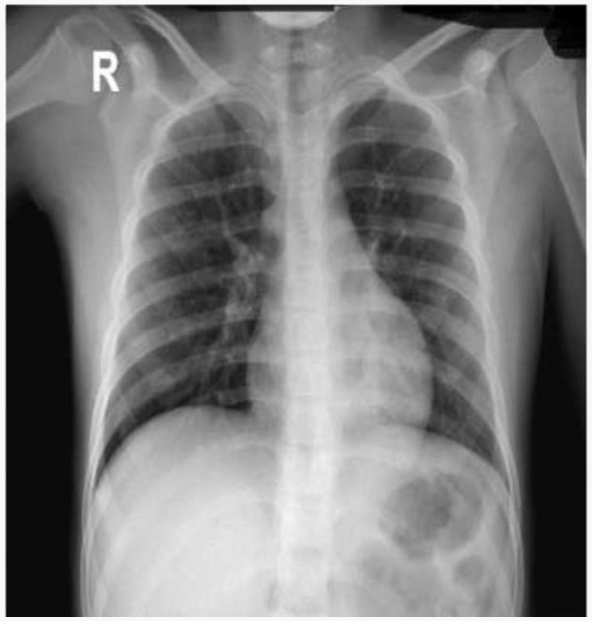



**Figure 1:** Chest Radiograph showing scattered, fine, bilateral infiltration**.**

**1. What is the diagnosis?**

**Atypical pneumonia**

**2. What is the etiological organisms?**

**Mycoplasma pneumonia**

**3. What is the management?**

# Case 7

A 53-years-old alcoholic male was transferred to the intensive care unit from a private hospital in a state of confusion, disturbed conscious level and diffuse abdominal pain. He was diagnosed as acute pancreatitis with multiple organ failure. He presented with sever sepsis secondary to community-acquired pneumonia (CAP) and pancreatitis. He was admitted to the Intensive Care Unit (ICU) because of acute respiratory distress syndrome (ARDS). He was intubated in septic shock. The patient was sedated, hemodynamically unstable and unconscious (coma scale: 6/15), (BP 134/68), (hyperthermia 39.2o C), (tachycardia 127 beats/min). laboratory investigation showed; WBCs 18 109/L. He was started empirically on tazocine. During his stay in the ICU, he had spikes of high temperature (40 $^{o}$C). Blood culture grew gram negative bacilli which was identified as Klebsiella *Pneumonia* (CRKP, MDRO), resistant to Tazocine, Imipenem and Ciprofloxacin and sensitive to Meropenem and Amikacin. Tazocine was suspended and Meropenem combined with Amikacin were started. Sputum culture grew oxidase positive, green colonies, *Gram-negative bacilli*. (MDRO), sensitive to Colistin. He was started on Colistin, Vancomycin and Caspofungen and continued on Meropenem and Amikacin. The patient became in a critical condition; he was in a refractory septic shock in spite of good coverage with many broad spectrum antibiotics. He deteriorated rapidly and died. Gene expert analysis revealed *K. pneumonia* isolate from the blood culture as carbapenemase producer (OXA-48+).

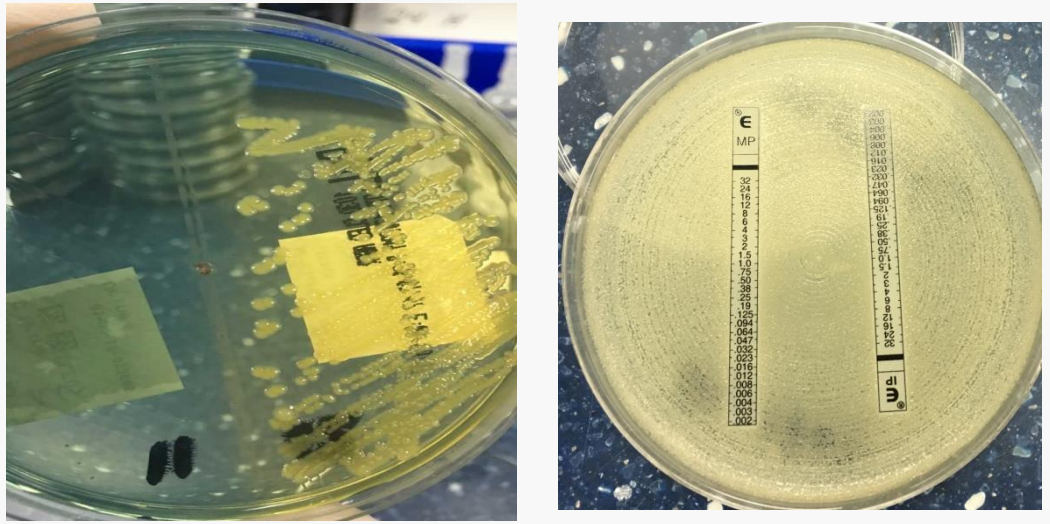


**Figure 1.** A- green colonies of oxidase positive gram-negative bacilli on MacConkey agar. **B-** sensitivity tests of Imipenem and Meropenem (E-test)

1. What is the most likely organism causing pneumonia ?

*Psudomonas aeruginosa*

1. What is the name of this type of pneumonia ?

Hospital acquired pneumonia

1. What are the main risk factors causing pneumonia in this case ?

Intubation

Prior broad spectrum antibiotics

Underlying disease

1. What are the options of treatment ?

Combination treatment

Colistin