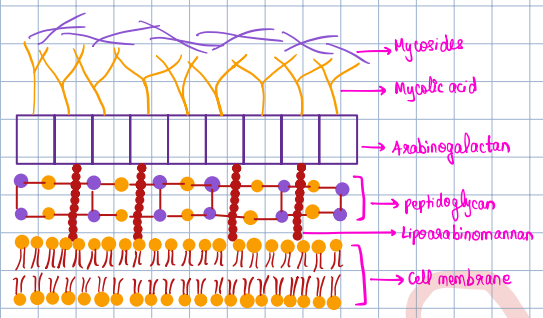
Organism	Classification	System of Infection	Properties of the organism	Clinical Manifestation	Laboratory Diagnosis	Pathogenesis	Treatment	Vaccination	Special Points
Streptococcus pyogenes [Group A streptococcus]	—	RS - bacterial pharyngitis	gram +ve, spherical, cocci, arranged in short chains, small pinpoint colonies on blood agar with a wide zone of β-hemolysis **Transmission:** through respiratory droplets	localised tonsilitis/diffuse pharyngitis, erythema & swelling of pharyngeal mucosa with purulent exudate formation **In younger children (< 3 years):** fever, malaise, lymphadenopathy without exudative pharyngitis **Suppurative complications:** peritonsillar or retropharyngeal abscess, pneumonia, empyema, meningitis **Non-suppurative Complications:** ARF, PSGN	**Specimen:** throat (oropharyngeal) swab **Culture:** on blood agar **Identification:** catalase -ve, susceptible to bacitracin **Rapid Antigen Detection Test (RADT):** for detection of group A carbohydrate antigen by latex agglutination or enzyme immunoassay. **ASO Titre:** Anti-streptolysin O antibodies **Molecular Test:** commercial PCR	—	**For pharyngitis:** benzathine penicillin G im single dose or oral penicillin V for 10 days **For recurrent pharyngitis:** clindamycin or amoxicillin-clavulanate **For concomitant pneumonia & empyema:** Penicillin G + drainage of empyema.	—	**Differentials:** • Diphtheria • Viral pharyngitis **Scarlet fever:** mediated by streptococcal pyogenic exotoxins (SPE-A,B,C) • pharyngitis + rashes (with sandpaper feel) + strawberry tongue (enlarged papillae on a coated tongue)
Corynebacterium diphtheriae	—	RS - diphtheria	gram +ve, non-capsulated, non-sporing, non-motile bacillus, irregularly stained, frequently shows club-shaped swellings **Chinese-letter/cuneiform arrangement:** due to snapping type of cell division **Metachromatic/Volutin granules/Polar bodies/Babes Ernst Bodies** present at poles of bacilli, strongly gram +ve, composed of polymetaphosphates, bluish-purple color when stained with Loeffler's methylene blue. **Albert's stain:** green bacilli with bluish-black metachromatin granules	**Respiratory diphtheria:** faucal diphtheria ⇒ inflammatory response that leads to necrosis of epithelium & exudate formation, mucosal ulcers lined by tough leathery greyish white pseudomembrane coat **Cutaneous diphtheria:** punched-out ulcerative lesions with necrosis (not toxin-mediated) **Systemic complications:** pneumonia, myocarditis, non-inflammatory demyelinating disorder, arrhythmias, encephalitis.	**Specimens:** throat swab containing fibrinous exudates, portion of pseudomembrane, nose or skin specimens **Direct smear microscopy:** Grams & Albert's stain **Culture Media:** • **Blood agar:** small, circular, white, hemolytic • **Loeffler's serum slope:** small, circular, glistening, white with a yellow tinge • **Potassium Tellurite Agar (PTA):** C. diphtheriae reduces tellurite to metallic tellurium giving them a black colour. **Identification:** pyrazinamide test negative, urease test negative, sugar fermentation test using Hiss' serum sugar media. **Toxin demonstration:** Elek's gel precipitation test, detection of tox gene by PCR, detection of DT by ELISA or ICT.	**Diphtheria toxin:** Fragment A & B. • toxin is secreted at local site (pharynx) & spreads to other sites via bloodstream. • Fragment B binds to host cell receptor & causes internalization of Fragment A • Fragment A internalization → ADP ribosylation of elongation factor (EF-2) → inhibition of EF-2 → inhibition of translation	**Should be started immediately on clinical suspicion of diphtheria** **Antidiphtheria Serum (ADS):** passive immunization prepared from horse serum • given IM or IV **Antibiotics:** play a minor role ∵ diphtheria is toxin-mediated **Doc = Penicillin** → useful for treatment of cutaneous diphtheria, carriers & prevent further release of toxin.	**Single vaccine:** toxoid **Combined vaccine:** DPT, Td, DaPT, pentavalent vaccine **Dosing schedule:** **Children:** total 7 doses - 3 doses pentavalent vaccine at 6,10,14 weeks - 2 DPT at 16-24 months & 5 years - 2 Td at 10 & 16 years **Pregnant woman:** 2 Td one month apart **Commercial preparations:** Glaxo & Kazaull	**Schick Test:** toxin-antitoxin neutralization test, to test susceptibility of individual to diphtheria before starting immunization (now obsolete)
Streptococcus pneumoniae (aka pneumococcus)	—	RS - Lobar pneumonia (transmission by inhalation of contaminated droplet nuclei) **Risk factors:** • children (< 2 years) • Splenectomy, Sickle Cell Disease & other Hb-opathies • Underlying comorbidities • viral URTI.	**Typing of S. pneumoniae:** by Quellung or Neufeld reaction. • specimen + type-specific antiserum along with methylene blue dye ⇒ capsule becomes swollen, sharply delineated & refractile	• pneumococci colonise the pharynx first **Lobar pneumonia:** productive purulent cough, fever, chest pain, dullness on percussion due to consolidation & crackles on auscultation. **Empyema & parapneumonic effusion** **Invasive Pneumococcal Disease (IPD):** bloodstream infection, pyogenic meningitis, osteomyelitis, arthritis, endocarditis, sinusitis	**Specimens:** sputum, CSF, pleural fluid, aspiration of sinus, ear discharge. **Direct Microscopy:** shows ↑ pus cells & lancolate or flame-shaped gram +ve cocci in pairs surrounded by a clear halo (due to capsule), non-motile, α-hemolytic **Antigen Detection:** • of Capsular antigen by latex agglutination test • of C-antigen/polysaccharide by ICT in urine **Culture:** **Blood agar:** initially ⇒ small dome shaped surrounded by a green zone of α-hemolysis; on prolonged incubation ⇒ autolysis occurs leading to a central depression with elevated rim (draughtsman shaped or carrom coin appearance) **Chocolate Agar:** greenish discolouration (bleeching effect) **Identification:** catalase negative, ferment inulin to form acid, sensitive to optochin disk & produce wide zone of inhibition, bile soluble. **Molecular method:** targetting lytA (autolysin gene), Ply (Pneumolysin) & psaA. **Nonspecific findings:** ↑ CRP, leukocytosis, chest X-ray shows patchy infiltrates & lobar consolidation.	**Capsular polysaccharide:** principle virulence factor, protects cocci from phagocytosis **C-Polysaccharide:** precipitates with CRP **Pneumolysin:** membrane-damaging toxin • Inhibits neutrophil chemotaxis & phagocytosis **Autolysin:** amidase enzyme which cleaves its own peptidoglycan leading to autolysis • responsible for bile solubility & draughtsman appearance of colonies **Pneumococcal surface proteins (PspA, PspC)** **IgA protease** **Neuraminidase** **Pneumococcal surface adhesin A (PsaA)**	**Pneumonia:** oral amoxicillin for 5 days (alternatives: IV penicillin/ceftriaxone, oral quinolone, clindamycin, azithromycin) **Meningitis:** ceftriaxone/cefotaxime ± vancomycin ⇒ for 10-14 days **Other invasive infections:** penicillin, cefotaxime/ceftriaxone **Critically ill patients:** same Tx as meningitis **otitis media:** oral amoxicillin, 7-10 days	• **pneumococcal polysaccharide vaccine (PPSV-23)** • **pneumococcal conjugate vaccine (PCV-13)** **Schedule:** **PCV13:** 3 primary doses at 6,10,14 weeks & booster at 12 months **Age > 65 yrs:** only PPSV23 or PCV13 followed by PPSV23 with ≥ 1 year gap **19-64 yrs:** given only in presence of underlying risk factors	• **S. pneumonia vs. viridans streptococci** • **PPSV23 vs. PCV13**
Haemophilus influenzae	6 serotypes (a to f) based on capsular polysaccharide • Hib is most virulent & is used in vaccine • some strains lack capsule & are non-typeable strains	RS - Lobar pneumonia **H. influenzae:** pneumonia & meningitis in children **H. ducreyi:** STD called chancroid **H. hemolytic & parahemolyticus:** produce hemolysis on blood agar.	oxidase +ve, capsulated, pleomorphic, gram -ve bacilli that require factor X & V in blood for growth, non-motile, catalase +ve, oxidase +ve **Transmission:** through respiratory droplets or contact with infected secretions or fomites • Common in < 5 years & 65 years of age.	**CNS Infections:** pyogenic meningitis, subdural effusion **Epiglottitis:** cellulitis of epiglottis & supraglottic tissues **Community Acquired Bacterial Pneumonia:** pneumonia in infants **Parameningeal focus:** sinusitis & otitis from which infection can spread to meninges **Less Common Invasive conditions:** pericarditis, osteomyelitis, empyema, UTI, septic arthritis, bronchiectasis.	**Specimen:** CSF, blood, sputum, pus, aspirates • H. influenzae is highly sensitive to low temperatures ∴ sample should never be refrigerated **Capsule detection:** by Quelling reaction **Antigen detection** **Culture:** no growth on basal media due to lack of factor X & V • growth is scanty on blood agar (∵ only factor X is available; factor V is present inside RBCs) • grows well on chocolate agar (∵ when blood is poured into molten agar at 75°C, RBCs get lysed to release factor V) • grows well on blood agar with S. aureus streak line by a phenomen called satellitism • Special media: Fildes agar, Levinthal's agar **Biochemical Tests** **Molecular Methods:** PCR, BioFire Film Array	**Capsular polysaccharide:** principle virulence factor; acts by inhibiting phagocytosis **Bacterial endotoxin** **outer membrane proteins** **IgA1 proteases** **pili & other adhesion proteins**	**For invasive infections due to Hib:** ceftriaxone, cefotaxime, etc for 1-2 week (alternative: ampicillin + chloramphenicol) **Non-typeable Strains:** often resistant to β-lactams due to production of β-lactamases • usually susceptible to quinolones (levofloxacin) & macrolides (azithromycin)	**Hib Conjugate vaccine (Pentavalent vaccine):** In combination with DPT & hepatitis B at 6,10,14 weeks • IM, anterolateral side of mid-thigh **Chemoprophylaxis:** oral rifampicin	—
Staphylococcus aureus	—	RS - Lobar pneumonia	—	**Leading cause of pneumonia in newborns & infants** **Infant pneumonia:** • presents with fever, dyspnea, respiratory failure • chest X-ray reveals pneumatocele ⇒ shaggy, thin-walled cavities **VAP in adults** **Post-viral CAP** **CA-MRSA**	—	—	—	—	—
Bacillus anthracis	—	RS - Pulmonary anthrax (Lobar pneumonia) aka Wool Sorter's Disease	transmission via inhalation of spores during exposure to contaminated animal products (seen in workers of a wool factory)	**Haemorrhagic pneumonia:** presents initially with prodromal stage of fever, myalgia, lethargy, followed by abrupt onset of haemorrhagic pneumonia leading to respiratory failure.	—	—	**Treatment with Anthrax Ig:** • Raxibacumab • obiltoxaximab } neutralize anthrax toxin	—	—
Yersinia pestis	—	RS - Pneumonic plague (Lobar pneumonia)	**Three clinical forms:** - bubonic - pneumonic - septicemic	fever, headache, cough, hemoptysis, dyspnea, chest pain	—	—	• Gentamicin or streptomycin	—	—
Mycoplasma pneumoniae PPLO/Eaton's agent	• Family mycoplasmataceae genus Mycoplasma genus Ureaplasma	RS - primary atypical pneumonia	• smallest microbes capable of free-living • lack rigid cell wall ∴ resistant to antibiotics acting on cell wall • highly pleomorphic, poorly gram -ve, non-sporing, non-flagellated, usually non-motile	**URTI:** pharyngitis, tracheobronchitis, Rarely otitis media (acute onset) **Pneumonia:** (gradual onset) • wheeze/rales, dry cough, peribronchial pneumonia with thickened bronchial markings & streaks of interstitial infiltration on chest X-ray **Extrapulmonary manifestations:** Neurologic: meningoencephalitis, encephalitis, aseptic meningitis, Guillain-Barre Syndrome Dermatologic: skin rashes including erythema multiforme major (Stevens-Johnson Syndrome) Cardiac: myocarditis, pericarditis Rheumatologic: Reactive arthritis Haematologic: anemia, hypercoagulopathy.	→ **Specimens:** throat swabs, nasopharyngeal aspirates, bronchial brushings, bronchoalveolar lavages (BAL), lung biopsies → **Transport media:** • Standard mycoplasma fluid medium [containing fetal bovine serum, gelatine, penicillin] • Viral transport medium with ampicillin & cefotaxime • **Culture:** → in liquid medium [containing PPLO broth]: turbidity & a color change → in solid medium [containing PPLO Agar]: "fried egg" appearance of colonies → Special stain: Dienes staining • **Antigen Detection:** by direct immunofluorescence test & ELISA • **Specific Antibody Detection Test:** - Immunofluorescence assays - latex agglutination assays - ELISA using protein P1 antigens • **Nonspecific Antibody Detection Tests:** heterophile agglutination tests such as: - Cold agglutination test - Streptococcus MG test • **Molecular Methods:** PCR targeting M. pneumoniae specific 16S rRNA gene & P1 adhesion gene	**Pathogenesis:** attachment of M. pneumoniae to respiratory mucosa mediated by its membrane bound adhesion proteins (eg: cytadhesion P1 protein) **Epidemiology:** transmitted by respiratory droplets → Incubation period = 2-4 weeks	**Treatment:** **Doc** = macrolides (azithromycin oral, 500 mg on day 1, 250 mg on days 2 to 5) → Alternatives: doxycycline, respiratory fluoroquinolones such as levofloxacin, moxifloxacin, gemifloxacin	—	—
Chlamydia		RS - Chlamydia pneumonia (atypical)			—	—	**Doc = tetracycline ⇒ 250mg,** 4 times a day for at least 3 weeks to avoid relapse. • Alternative: erythromycin ⇒ 500mg 4 times a day P.O.	—	—
c. psittaci		Psittacosis	• pathogen of parrots & other psittacine birds • transmitted to humans by inhalation of aerosols from avian nasal discharge	mild influenza, atypical pneumonia, septicemia, typhoid-like symptoms					
c. pneumoniae		Atypical Pneumonia	—	atypical pneumonia, URTI, atherosclerosis, asthma, COPD					
c. trachomatis		Infant pneumonia	—	-					

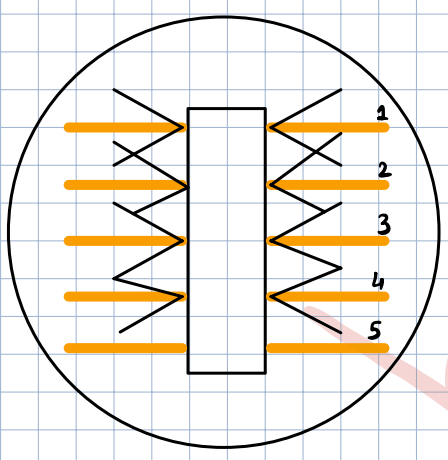
Organism	Classification	System of Infection	Properties of the organism	Clinical Manifestation	Laboratory Diagnosis	Pathogenesis	Treatment	Vaccination	Special Points
Legionella pneumophila		RS - Legionellosis aka Legionnaire's disease	fastidious, gram-ve bacilli, Pleomorphic, poorly stained ∴ appear faintly transmission via aerosols from contaminated air conditioners, nebulizers, humidifiers or via oro-pharyngeal colonization or via directly drinking of contaminated water.	Pontiac fever: acute flu-like symptoms • malaise, fever, headache • self-limiting, never develops into pneumonia Legionellosis: non-productive cough, dyspnea, chest pain, high fever, diarrhoea, chest x-ray shows pulmonary infiltrates Extrapulmonary Legionellosis: due to hematogenous dissemination from the lung • most common site: heart (myocarditis, prosthetic valve endocarditis, pericarditis) • sinusitis, peritonitis, etc.	Specimen: Sputum, BAL fluid, bronchial wash, pleural fluid • Direct microscopy: poorly Gram-stained • silver impregnation & giemsa can be used • Culture: Buffered Charcoal Yeast Extract Agar (BCYE) • Antibody Detection: indirect IF antibody test & enzyme immunoassays • Urinary Antigen Detection: by enzyme immunoassays • Molecular method: BioFire FilmArray	Legionellae reach the lungs → engulfed by alveolar macrophages by coiling phagocytosis → invasion & growth within alveolar macrophages by inhibiting phagosome-lysosome fusion → activation of cell-mediated immunity	Macrolides (especially azithromycin) & respiratory quinolones (levofloxacin)	-	• Legionella inhabits aquatic bodies • no man-to-man transmission
Bordetella pertussis B. parapertussis ⇒ B. bronchiseptica ⇒ pathogen of domestic animals.	Family Alcaligenaceae milder form of pertussis	RS - Pertussis/ Whooping cough transmission via inhalation of droplets or rarely through direct contact.	gram-ve coccobacilli, strict anaerobe • Requires special complex medium for primary isolation eg: Regan & Lowe medium, Bordet-Gengou glycerine-potato-blood agar. • Colonies are greyish white, convex with a shiny surface ⇒ Mercury drops & Bisected Pearl Appearance • encd, arranged in loose clumps with clear spaces in between ⇒ Thumb print appearance	3 STAGES Catarrhal Phase: common cold like non-specific symptoms (coryza, mild cough, lacrimation, fever, malaise) for 1-2 weeks • highly infectious stage Paroxysmal Phase: less infectious • whooping cough, post-tussive vomiting for 1-6 weeks Convalescent Stage: frequency & severity of cough gradually decreases • 1-3 months. COMPLICATIONS: more common in infants • Pressure effects: subconjunctival haemorrhage, hernias, pneumothorax, rib fracture, petechiae • Pneumonia: in old age • Neurological complications: convulsions, encephalopathy, coma	Specimens: nasopharyngeal secretions Types of Swabs: alginate or dacron swabs for culture • dacron or rayon swabs for PCR • cotton swabs X ∵ fatty acids present in cotton may inhibit growth of bacilli • charcoal-impregnated cotton swabs can be used Transport medium: If delay is expected, then a suitable charcoal based medium [Amies, Regan-Lowe, Jones-Kendarck transport media] Direct detection: by IF test using fluorescin labelled antibodies. Culture: Gold standard Serum Antibody Detection: Enzyme immunoassays Molecular methods: PCR remains +ve in the first 4 weeks. Other findings: lymphocytosis in young children.	bacteria attach to ciliated epithelial cells of nasopharynx, multiply by producing toxins to cause local mucosal damage & ∴ host defense mechanism	• antibiotics are less useful ∵ pertussis is toxin mediated • Doc: macrolides (azithromycin for 5 days or erythromycin for 7-14 days • alternative: cotrimoxazole • Cough suppressants are ineffective • Chemoprophylaxis: erythromycin	whole Cell Pertussis Vaccine: heating followed by chemical inactivation & purification of whole bacilli. DPT: Diphtheria toxoid + tetanus toxoid + whole-cell pertussis Acellular Pertussis Vaccine: pertussis toxoid & 2 or more other bacterial components such as FHA, pertactin, fimbriae • associated with fewer side effects • available as DaPT → recommended for older children who have missed their primary doses of DPT.	paroxysmal cough ending in a high-pitched inspiratory sound described as whoop • each paroxysm consists of bursts of 5-10 repetitive violent spasmodic coughs, often with a single expiration which ends with an audible sound or whoop → whoop occurs due to rapid inspiration against a closed glottis at the end of the paroxysm • episodes are often worse at night • during a spasm, there may be visible neck vein distention, bulging of eyes, tongue protrusion & cyanosis • weight loss may be seen (fewer in vaccinated)

Features	S. pneumoniae	Viridans streptococci
Arrangement	gram +ve cocci in pairs	gram +ve cocci in long chains
Morphology	Lanceolate-shaped	Round/oval
Capsule	Present	Absent
On blood agar	Draughtsman or carrom coin colony	minute colony
Bile solubility	soluble	insoluble
Inulin	fermented	not fermented
Optochin	sensitive	resistant

	PPSV 23	PCV 13
Serotypes included	23 serotypes of S. pneumoniae	13 serotypes of S. pneumoniae
Immunogenicity	Less immunogenic (∵ capsular antigen is T cell independent)	More immunogenic (protein conjugate acts as adjuvant)
Duration	short term immunity (3-5 years)	longer immunity
Herd	promotes herd immunity	does not promote
Effect on carriers	doesn't provide mucosal immunity ∴ not effective for carriers	provides mucosal immunity ∴ can be used to eradicate carriage from nasopharynx
Cost	Less expensive	More expensive

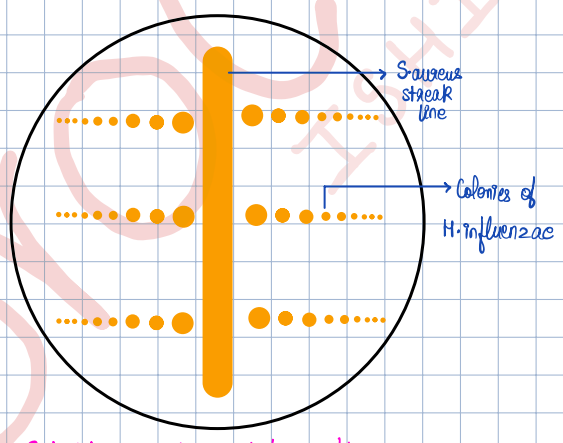


Cell Wall of M. tuberculosis

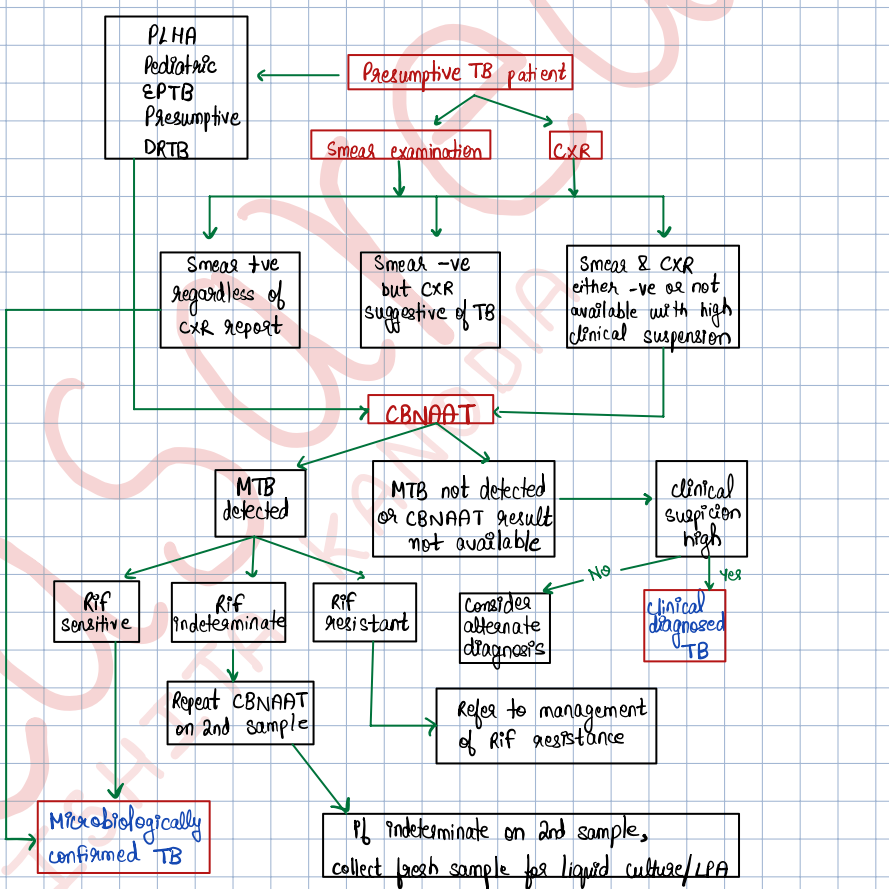


Isolate 1 & 2: cross-over of bands
Isolate 2 & 3: partial fusion/spur formation
Isolate 3 & 4: fusion of bands
Isolate 5: no precipitation band formed ⇒ non-toxigenic

Elek's gel electrophoresis



Satellitism of Haemophilus influenzae



Diagnostic algorithm for pulmonary tuberculosis