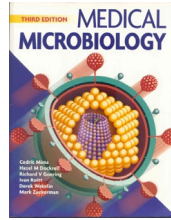


RTI = Respiratory Tract Infections

Prof Peter O'Donoghue



RT
Upper RTI
Lower RTI

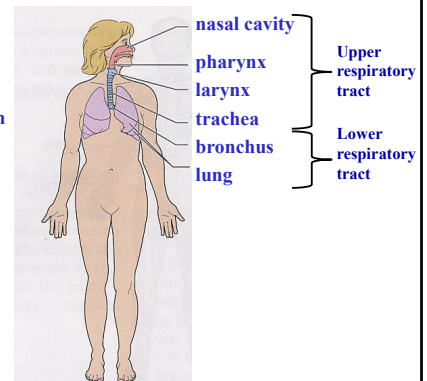


Mims 3rd Edition, Chapter 18

1

Respiratory system

- ventilation system
- oxygenates blood
- removes carbon dioxide



2

Microbiology of respiratory system

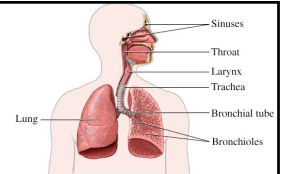
Microbes present?

URT? LRT?

Why?

3

Flora

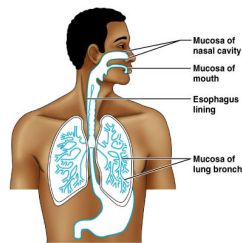


- Respiratory tract is open to the outside environment
- Therefore open to organisms from the environment
- URT contains many normal flora
- BUT alveolar membrane needs to be kept clear (for gas exchange)
- => no normal flora in the LRT
- How?

4

Respiratory tract defenses

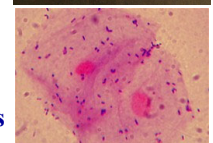
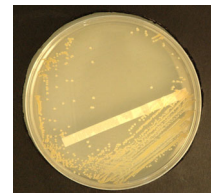
- Nasal structure
- Nasal hairs
- Mucus
- Ciliated epithelial cells
- Cough reflex
- Secretory antibodies
- Normal flora



5

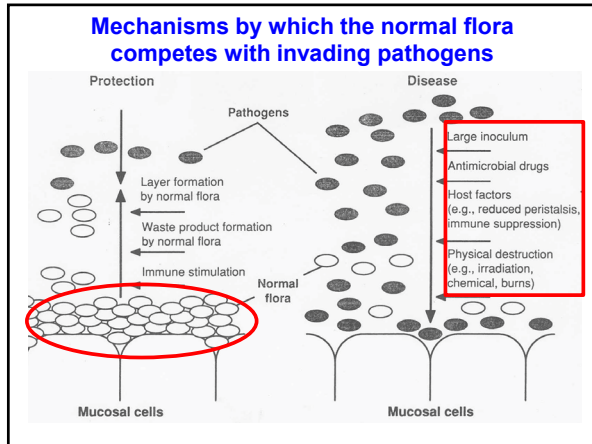
Which organisms are there as normal flora?

Staphylococcus aureus
Streptococcus pneumoniae
Neisseria meningitidis
Haemophilus influenzae
“Diphtheroids”
Corynebacterium spp.
[not *C. diphtheriae*]
and others (incl. *Candida*)



Compete for attachment sites
Produce bacteriocidal products

6



7

Transmission

- **Aerosol (cough, sneeze, etc)**
 - Live, viable dose
- **Susceptible host**
 - Age
 - Immune status
 - Concurrent disease
 - Smoking
 - Intubation, ventilation
 - Length of hospitalisation

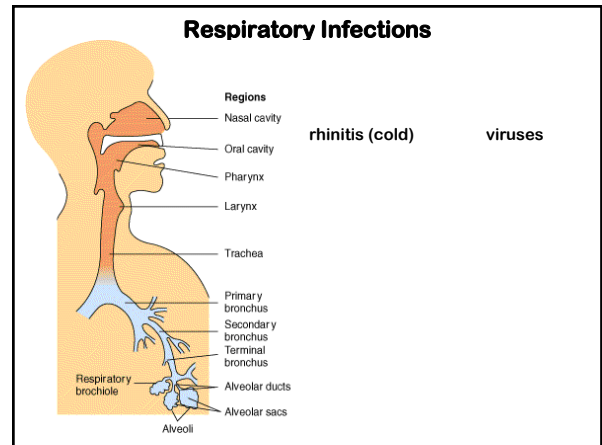
8

Initiating disease

Mechanisms of pathology

- Bacterial adherence factors
- Extracellular toxins
- Growth/replication in host tissues
- Evade host defence mechanisms

9



10

Common cold

Common causes

- Rhinovirus
- Picornavirus
 - Respiratory syncytial virus
 - Influenza virus
 - Parainfluenza virus
- Coronavirus
- Mycoplasma pneumoniae*

Direct contact

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Common cold pathology (inflammation, mucus)

Rhinitis (nose)

Eustachian tubes (middle ear)

- otitis media

Sinusitis (sinuses)

Labels in diagrams: Inflamed membranes, Post-nasal drip, Tympanic membrane, External ear canal, Eustachian tube, Pharynx, Fluid trapped in middle ear by infection.

12

Acute otitis media


Mostly viral
Some bacterial

Signs
ear ache
fluid
glue ear
sore throat
irritability
restlessness
disrupted sleep
fever

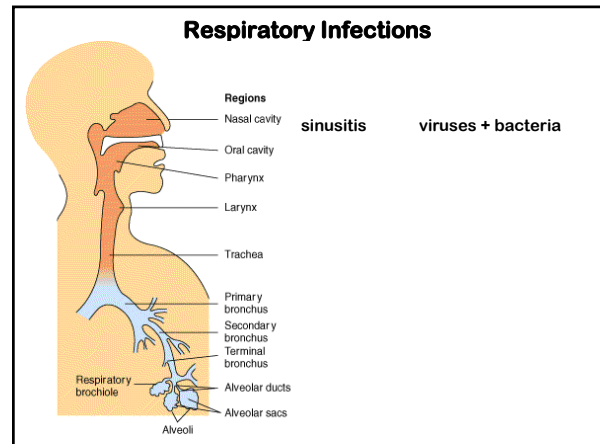
Risk factors

Common in children
Young age
Male
Around smokers
Day care

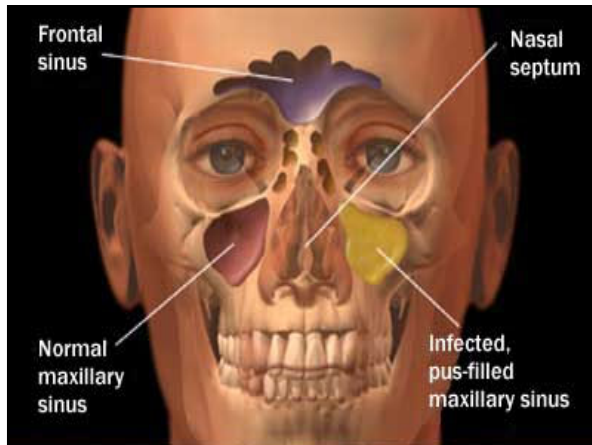
Treatment
Supportive care
Antibiotics?
Grommets



13



14



15

Sinusitis

Common causes of acute sinusitis
Haemophilus influenzae
Streptococcus pneumoniae
Chlamydia pneumoniae

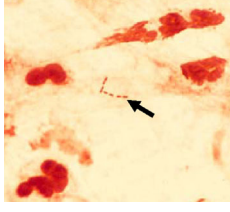
Causes of chronic sinusitis
 Anaerobic + aerobic bacteria

Treatment
 Analgesia
 Drainage/vasoconstriction
 Antibiotics

16

Exemplar: ***Haemophilus influenzae***

- Characteristics**
 - Gram -ve rod (URT flora)
- Epidemiology:**
 - URTI: Otitis media, Sinusitis, Epiglottitis.
 - LRTI: Pneumonia
 - Other: Meningitis
- Pathogenesis:**
 - Main virulence factor: Capsule
 - Others: Outer membrane proteins OMPs), endotoxin, pili, IgA protease
- Treatment and prevention:**
 - Ampicillin[®] increasing.
 - Hib vaccine (no vaccine for non-encapsulated strains)



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Comparison of encapsulated (type b) and non-encapsulated (non-typable) *H. influenzae*

Characteristic	Type b	Non-typable
Agglutination with polyvalent capsular antisera	present	absent
Host range	children	children & adults
Nasopharyngeal carriage	2-4%	40-80%
Typical diseases	epiglottitis pneumonia meningitis arthritis pericarditis cellulitis	otitis media sinusitis bronchitis pneumonia conjunctivitis
Bacteremia	common	unusual

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Haemophilus influenzae type b

- Carrier rates: Up to 15% of children in non-immunized populations may harbour Hib in their nasopharynx.
- >3 million cases each year (WHO) with 400,000–700,000 deaths
- Disease burden highest at 4-18 months

Graph 12: Reported cases of Haemophilus influenzae meningitis in England & Wales, 1989 - 2001

Source: CDSC

19

Nontypable *H. influenzae*

- Second most common cause of acute otitis media
- Causes 1/3 of all episodes of acute or chronic sinusitis
- Important cause of pneumoniae in developing countries
- Spread of infection associated with reduced host defences (preceding viral infection, cigarette smoke)

Important virulence properties

- Fimbrial and non-fimbrial adhesins (adhesion, aggregation, invasion)
- IgA protease
- Lipopolysaccharide (endotoxin is highly toxic)

20

Respiratory Infections

pharyngitis viruses + bacteria

21

Pharyngitis

Signs

- Sore throat - tonsillitis
- Malaise, Fever

Common causes

Viral (90% adults, 70% children)

- rhinovirus
- respiratory syncytial virus
- herpes virus type A
- influenza
- Epstein-Barr virus

Bacterial

- group A beta haemolytic streptococcus (= GABHS = *Streptococcus pyogenes* = "strep throat")

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GABHS pharyngitis

"Strep throat"

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Exemplar: *Streptococcus pyogenes*

- Characteristics**
 - Gram +ve cocci, normal flora (URT, skin)
 - 5-15% carrier rate
- Epidemiology:**
 - air-borne/contact
 - common in winter
- Treatment:**
 - penicillin (erythromycin when penicillin allergy)
 - no vaccine
- Disease:**
 - Pharyngitis ± complications (acute glomerulonephritis, rheumatic fever)
 - Virulence factors: **enzymes**, exotoxins, capsule, adhesins

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GABHS (*Streptococcus pyogenes*) virulence factors

Enzymes:

- streptokinase: lyse blood clots
- hyaluronidase: cleaves tissue
- streptolysins: lyse RBCs/WBCs
- DNase: degrades DNA

Exotoxins:

- Erythrogenic toxin
- Toxic shock syndrome toxin

Capsule:

- Prevents phagocytosis

Adhesins: M-protein; F-protein; Lipoteichoic acid.

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Laboratory identification: Haemolysis

Throat swab (culture on blood agar)

Beta-haemolysis (complete lysis of RBCs)

Alpha-haemolysis (partial "green" haemolysis, haemoglobin reduction)

ASM Microbiology: Tomalty and Delisle

GABHS also sensitive to bacitracin
Group specific carbohydrates

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Laboratory identification:

Streptococci are classified serologically into Lancefield groups:

1. *S. pyogenes* is Group A antigen (GAS)
Pharyngitis; skin infections: nearly always Beta haemolysis
2. *S. agalactiae* is Group B antigen (GBS)
UTI's; pneumonia; neonatal meningitis: Alpha, Beta and non-haemolytic
3. *S. pneumoniae* is no antigen (no Lancefield antigens)
Pneumonia; meningitis: nearly always Alpha haemolysis

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Complications

Rare when treated.
If spread occurs, there may be:

- Scarlet fever (rash)
- Otitis media and sinusitis
- Peritonsillar abscess
- Acute glomerulonephritis (Ab-Ag deposits in glomeruli)
- Rheumatic fever (chronic, progressive damage to heart valves due to inflammatory response)

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Respiratory Infections

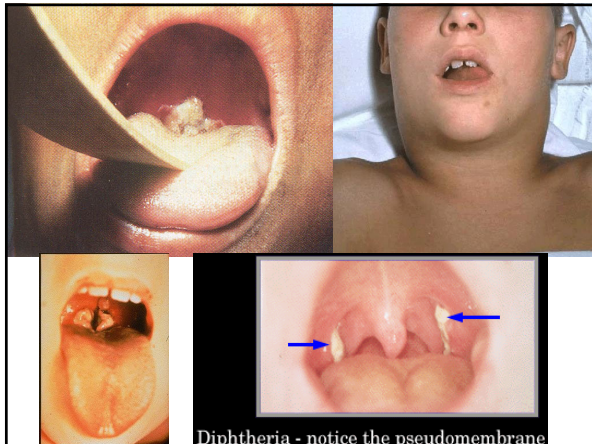
diphtheria bacteria

29

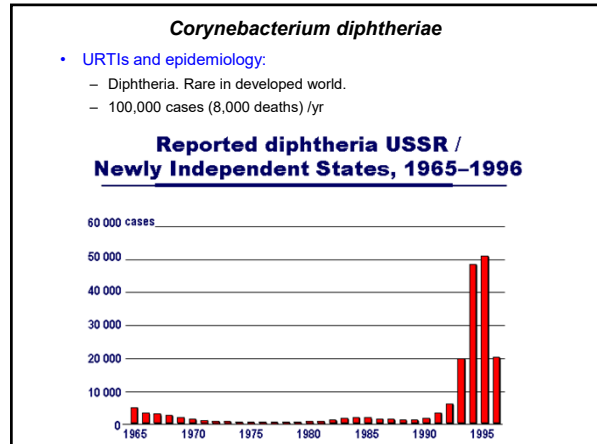
Exemplar: *Corynebacterium diphtheriae*

- **Characteristics**
 - Gram +ve rod, normally in nasopharynx
 - spread by air-borne droplets + direct contact
- **Disease:**
 - ulceration (pseudomembrane), fetid breath
 - oedema, lymphadenopathy
 - death
 - toxin (inhibits protein synthesis, highly toxic, affects heart, nerves)
- **Treatment:**
 - anti-toxin (anti-serum) to neutralize toxin
 - antibiotics (erythromycin)
 - vaccination (toxoid = altered form of toxin) [part of DTP vaccine] [Almost eradicated in Australia]

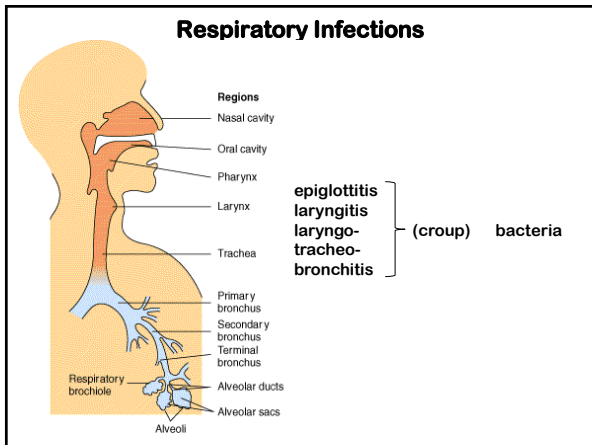
30



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32



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Epiglottitis

Signs

- Dysphagia
- Dysphonia
- Drizzling
- Distress
- Emergency!**

Common cause

H. influenzae

Tx

- Cefotaxime
- Tracheotomy

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Laryngotracheobronchitis

Parainfluenza virus (common)

Haemophilus influenzae (Hib)

Corynebacterium diphtheriae

Mycoplasma pneumoniae

35

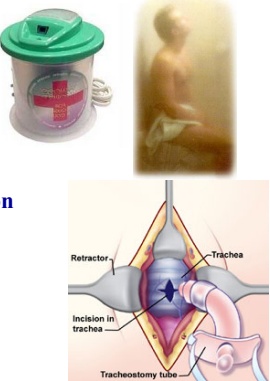
Upper respiratory tract infections

Disease	Infecting organisms	Comments
Common cold	Viruses, eg Rhinoviruses	Many serotypes
Acute Otitis media	Viruses (esp. RSV) <i>S. pneumoniae</i> , <i>H. influenzae</i> , <i>M. catarrhalis</i> <i>S. pyogenes</i> , <i>S. aureus</i>	Cause at least 50% of cases Generally secondary infection. Most commonly nasopharyngeal residents. Fluid often persists in middle ear for weeks-months (glue ears)
Acute Sinusitis	Etiology & pathogenesis similar to Acute otitis media	
Pharyngitis	Viruses <i>Streptococcus pyogenes</i> <i>Neisseria gonorrhoeae</i> <i>Corynebacterium diphtheriae</i> <i>Haemophilus influenzae</i>	Cause approx 70% of sore throats 10-20% acute cases; sudden onset; mostly 5-10 yo's Often asymptomatic, usually via orogenital contact Mild but toxic illness can be severe Epiglottitis
Diphtheria	<i>C. diphtheriae</i>	Rare in developed countries (immunisation)
Acute epiglottitis	<i>H. influenzae</i> type b	Organism spreads from nasopharynx to epiglottis
Laryngitis & Tracheitis	Parainfluenzae virus, RSV, GpA Strep, <i>H. influenzae</i> , <i>S. aureus</i>	Viruses cause most infections

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Management overview – URTI's

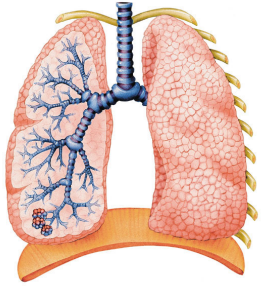
- Humidified air
- Oxygen
- Calm handling
- Tracheostomy, intubation
- Antibiotics
- Antitoxin (diphtheria)
- Vaccination



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Lower respiratory tract infections

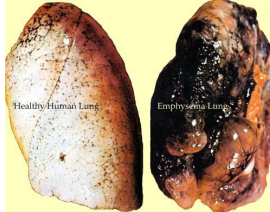
- Respiratory airways
 - Bronchi
 - Bronchioles
- Lungs
 - Alveoli
 - Interstitial tissues



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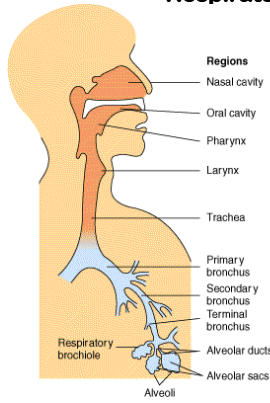
Lower respiratory tract infections

- Modes of transmission
 - Inhalation
 - Aspiration
 - Haematogenous
 - Direct extension
 - Penetration & contamination



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Respiratory Infections



Regions

- Nasal cavity
- Oral cavity
- Pharynx
- Larynx
- Trachea
- Primary bronchus
- Secondary bronchus
- Terminal bronchus
- Respiratory bronchiole
- Alveolar ducts
- Alveolar sacs
- Alveoli

bronchitis viruses + bacteria
bronchiolitis

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Bronchitis

Common causes

- Respiratory viruses (+ measles)
- Mycoplasma pneumoniae*
- Chlamydia pneumoniae*
- Bordetella pertussis* (whooping)
- Streptococcus pyogenes*

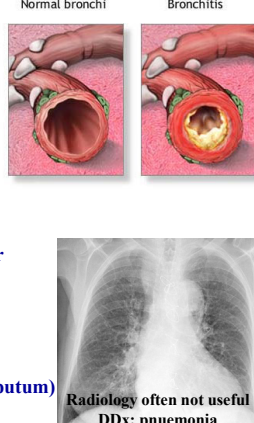
Common symptoms

- Malaise, headache, sore throat, fever
- Cough
 - non-productive
 - mucopurulent

Treatment

- Supportive therapy
- Antibiotics (fever + mucopurulent sputum) (do culture)

Radiology often not useful
DDx: pneumonia



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Bronchiolitis

Common causes

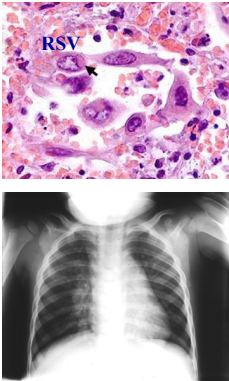
- Respiratory syncytial virus
- Influenza, Parainfluenza viruses
- Adenoviruses, Rhinoviruses
- Mycoplasma pneumoniae*

Common symptoms

- Malaise, headache, coryza, fever, cough
- Respiratory obstruction (/// asthma)
- Respiratory distress, cyanosis

Treatment


- Supportive therapy
- Monitor for progression/depression



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Exemplar: *Bordetella pertussis*

- Characteristics**
 - Gram -ve coccobacilli, difficult to culture
- Disease:**
 - Pertussis (whooping cough), can be fatal in young children
 - 7-20 day incubation period
 - toxin → tissue damage → mucus production, neurological effect, cerebral haemorrhages
 - persistent cough (inspiratory stridor = 'whoop')
- Transmission:**
 - Highly contagious, spread by respiratory droplets
- Treatment and prevention:**
 - Supportive care, antibiotics for secondary/super-infections (e.g. *Staphylococcus aureus*)
 - Vaccination (acellular and whole cell vaccines)
 - Re-emergence of disease over last decade

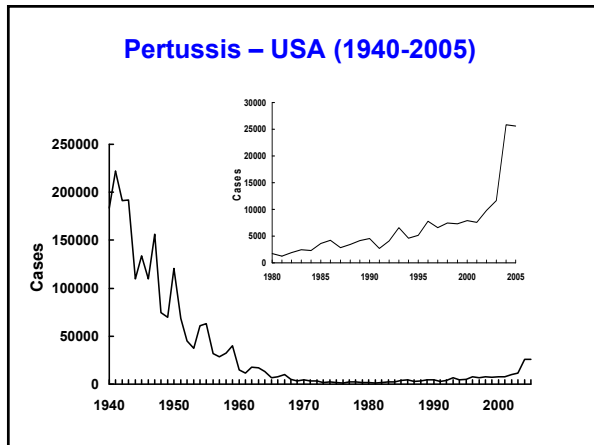


43

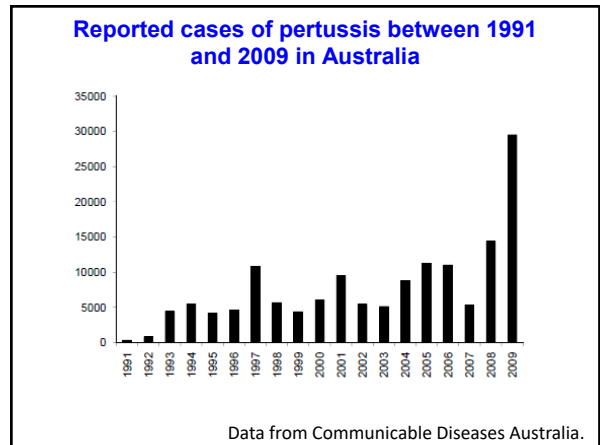
National Immunisation Program Schedule as November 2009

AGE	DISEASE	VACCINE
Birth	Hepatitis B	Hepatitis B
2 months	Diphtheria, Tetanus, Pertussis Poliovirus Haemophilus influenzae type b, Hepatitis B Pneumococcal	DTPa-IPV Hib-HepB 7-PCV
4 months	Diphtheria, Tetanus, Pertussis Poliovirus Haemophilus influenzae type b, Hepatitis B Pneumococcal	DTPa-IPV Hib-HepB 7-PCV
6 months	Diphtheria, Tetanus, Pertussis Poliovirus Pneumococcal	DTPa-IPV 7-PCV
12 months	Mumps, Measles, Rubella Haemophilus influenzae type b, Hepatitis B Meningococcal C Pneumococcal (eligible children only) ¹	MMR Hib-HepB MenCCV 7-PCV
18 months	Varicella (chickenpox) Hepatitis A (eligible children only) ²	VCV Hepatitis A
24 months	Pneumococcal (eligible children only) ³ Hepatitis A (eligible children only) ²	23-PPV Hepatitis A
4 years	Diphtheria, Tetanus, Pertussis Poliovirus Mumps, Measles, Rubella Pneumococcal (eligible children only) ⁴	DTPa-IPV MMR 23-PPV
13 years	Hepatitis B Varicella (chickenpox) ⁵	H.B.Vax II VCV
15 years	Diphtheria, Tetanus, Pertussis ⁶	dTpa

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Queensland Health warns whooping cough is spreading

Smallen Hinde
March 21, 2009 11:00pm
Article from **Sunday Mail**

THE highly infectious and potentially fatal disease, whooping cough, is rapidly spreading throughout Queensland, Queensland Health has warned.

The number of cases was three times higher than would normally be expected.

There have been 879 cases in all age groups in the first 10 weeks of this year across the state.

"We started to see a lot of cases in October and November and it has continued on into this year."

A baby died from whooping cough in the Tweed Heads area on March 9.

The north coast of New South Wales has been identified as an area where large numbers of children are going unvaccinated, with only 81.4 per cent of children receiving the jabs against whooping cough.

Newborn babies are at significant risk of dying from the disease, which spreads from people coughing droplets of the virus into the air. There have been 27 cases of whooping cough in babies under six months this year in Queensland and authorities are urging parents to vaccinate their children.

"The group we are most worried about is babies," Dr Selvey said.

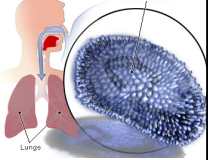
"Babies under 12 months are in more danger of serious complications such as brain damage, because they can cough so violently that not enough oxygen gets to the brain."

Queensland's immunisation rates for whooping cough stand at 91.3 per cent - just below the national average.

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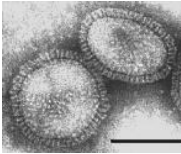
Exemplar: Influenza

- Characteristics**
 - ssRNA virus, with envelope containing:
 - Haemagglutinin surface glycoprotein (16 H types)
 - Neuraminidase surface glycoprotein (9 N types)
- Disease:**
 - Influenza (flu). Highest risk for elderly and immunocompromised individuals
 - Multiple symptoms, may develop into bronchitis or pneumoniae.
 - May also lead to secondary bacterial infections
- Transmission:**
 - Highly contagious, spread by respiratory droplets and fomites

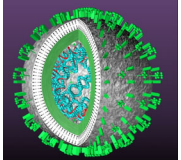


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Influenza



Surface glycoproteins
H = haemagglutinin
N = neuraminidase



Type A (humans, animals, birds)
- every 2-3 years

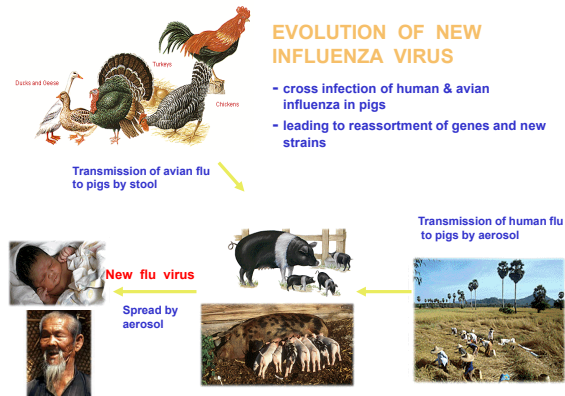
Type B (humans only)
- every 4-6 years

Overall mortality ~ 1% BUT epidemics (pandemics) killed millions

H1N1 Spanish flu (1918) 40m deaths
H2N2 Asian flu (1957) 2m deaths
H3N2 Hong Kong flu (1968) 1m deaths
H1N1 Russian flu (1977) no pandemic
H5N1 bird flu (1997) 6 deaths

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EVOLUTION OF NEW INFLUENZA VIRUS



Transmission of avian flu to pigs by stool

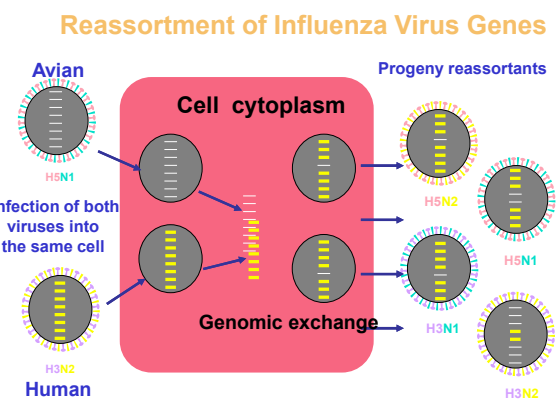
Transmission of human flu to pigs by aerosol

New flu virus

Spread by aerosol

50

Reassortment of Influenza Virus Genes



Avian H5N1

Human H3N2

Cell cytoplasm

Genomic exchange

Progeny reassortants

H5N2, **H5N1**, **H3N1**, **H3N2**

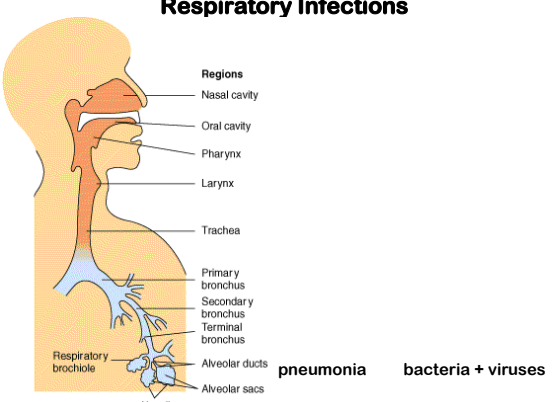
51

Influenza

<p>Risk of death</p> <ul style="list-style-type: none"> Very young Very old Cardiovascular disease Pulmonary disease Renal disease etc Pregnancy 	<p>Treatment and prevention</p> <ul style="list-style-type: none"> Supportive Antipyretics Analgesics Antivirals (if given early) Amantadine Relenza Vaccination (annual) At-risk groups
---	---

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Respiratory Infections



Regions

- Nasal cavity
- Oral cavity
- Pharynx
- Larynx
- Trachea
- Primary bronchus
- Secondary bronchus
- Terminal bronchus
- Respiratory bronchiole
- Alveolar ducts
- Alveolar sacs
- Alveoli

pneumonia **bacteria + viruses**

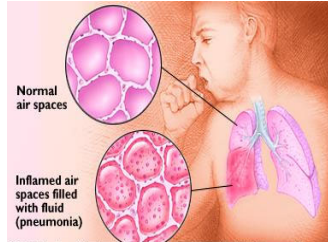
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Pneumonia

Infection of the lungs.

Accumulation of white blood cells and bacteria cause the alveoli to fill with fluid.

Air spaces become inflamed and filled. Breathing affected.



Normal air spaces

Inflamed air spaces filled with fluid (pneumonia)

Typical pneumonias: characterised by respiratory symptoms.

Atypical pneumonias: characterised by general/systemic symptoms.

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Pneumonia

- Acute illness
- Radiological shadowing
- Setting
 - community-acquired
 - nosocomial
 - aspiration
 - immunocompromised

• CURB65 (1 pt for each)

- Confusion
- Urea (>7)
- Respiration (>30)
- Blood pressure (<90)
- age >65

[4-5 pts → 40% mortality]

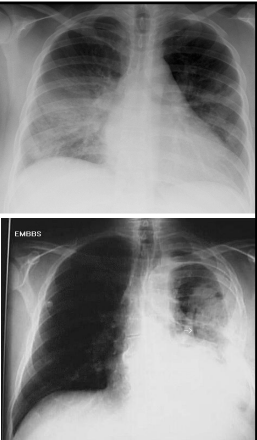
55

Pneumonia

Reduced air exchange
Systemic effects
 Fever, Shock, Wasting
 Relatively high mortality

Complications

- Sterile pleural effusion
- Empyema (purulent exudate)
- DIC (coagulation)
- Bronchiectasis (dilation)
- Chronic pneumonia
- Altered blood gases



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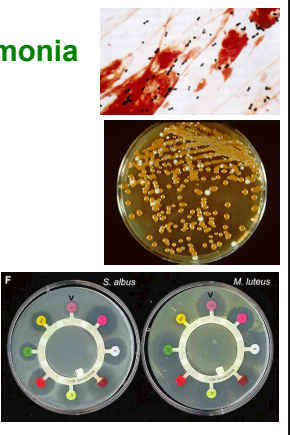
Modes of transmission

- **Inhalation:**
 - airborne transmission
- **Aspiration:**
 - usually resident nasopharyngeal flora
 - often occurs during sleep
 - Common in alcohol/drug users, comatose patients
- **Haematogenous spread:**
 - To lung from another site of infection
- **Direct extension**
 - From a contiguous site of infection
- **Exogenous penetration and contamination**
 - Accidental trauma or surgery

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Diagnosis of pneumonia

- Symptoms
- Sputum sample-
satisfactory sample
- Gram stain
- Culture
- Antibiotic sensitivity



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Pneumonia

Causes – children

- Group B streptococcus
- RSV
- Chlamydia trachomatis*
- Mycoplasma pneumoniae*
- Influenza virus

Causes – adults

- Mycoplasma pneumoniae*
- Streptococcus pneumoniae*
- Haemophilus influenzae*

- immunocompromised
 Gram negative organisms

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Typical pneumonias

Community acquired

- Streptococcus pneumoniae* (most common)
- Haemophilus influenzae*
- Klebsiella pneumoniae*
- Neisseria meningitidis*

Atypical pneumonias

- Mycoplasma pneumoniae*
- Chlamydia pneumoniae*
- Legionella pneumophila*

Viruses (influenza)

Fungi

60

Nosocomial pneumonia


Prevalence
0.5 – 5% hospitalised patients
higher in ICU, postoperative patients

Organisms
Gram –ve bacilli (microaspiration during sleep)

Antibiotic resistance
Recent antibiotic therapy
Longer than 2 days in hospital
Immune suppression
Bronchiectasis (dilation)

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Ventilator-associated pneumonia

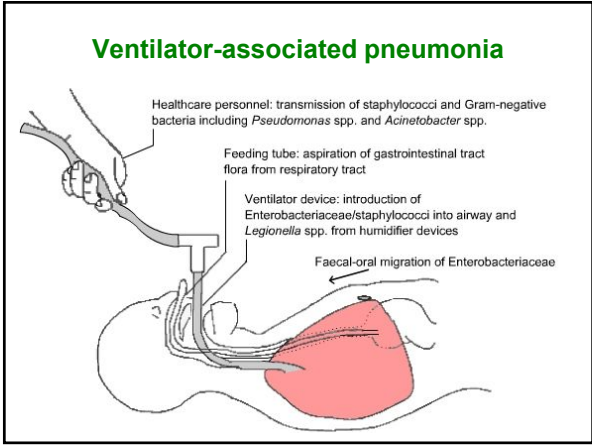


High mortality – 40%

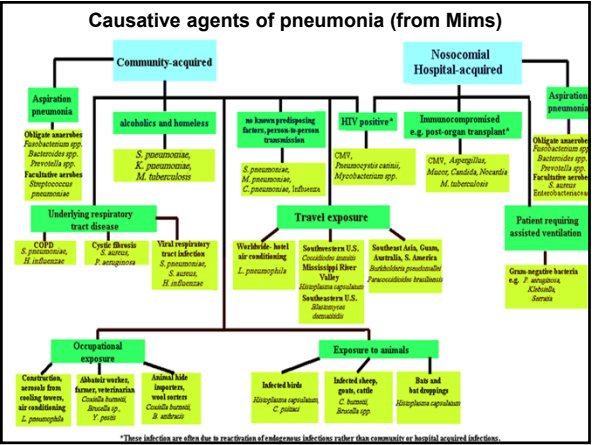
Causes ARDS

Predisposing
Endotracheal tube
Muscle relaxants
Pre-existing sinusitis, pharyngitis

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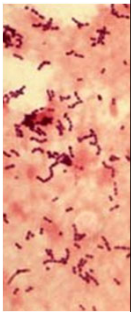
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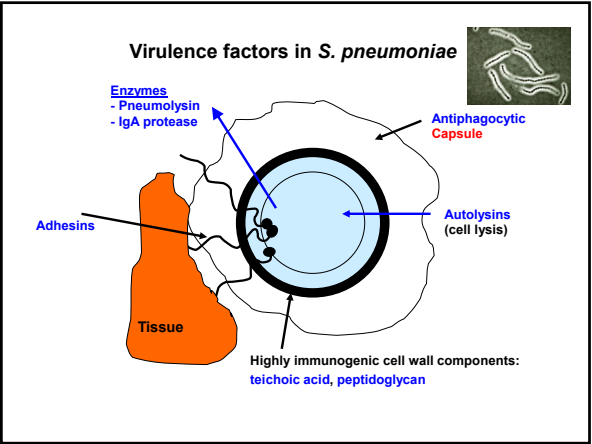
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Exemplar: *Streptococcus pneumoniae*

- Characteristics**
 - Gram +ve diplo-cocci (normal URT flora)
- Epidemiology:**
 - Otitis media, Sinusitis, LRTIs (pneumonia), meningitis
- Transmission:**
 - About 5% of population carriers
 - Spread by airborne droplets and direct contact
- Pathogenesis:**
 - Capsule
 - Pneumolysin
- Treatment and prevention:**
 - Antibiotics (penicillin)
 - Vaccination (conjugate vaccine available)



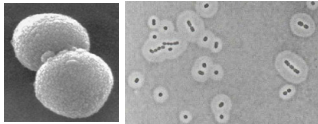
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Polysaccharide capsule

- >90 serotypes
- 80% of invasive disease in children caused by 7 serotypes (4, 6B, 9V, 14, 18C, 19F, and 23F)
- major virulence factor: **capsule** (interferes with **phagocytosis**)
- Increases virulence by 100,000-fold
- **Highly antigenic** (immunity directed against capsule)



India ink stain of capsular material

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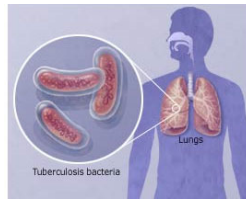
Pneumococcal vaccines

- **23-valent (Pneumovax)**
 - Covers the about 90% of disease in adults
 - Doesn't work in children <2 years of age (because they do not respond to T cell-independent antigens)
- **7-valent (Prevenar)**
 - A new conjugated pneumococcal vaccine
 - Covers about 80% of disease in children in the U.S.
 - Over 90% protective against invasive disease with bacteremia. Less protective against otitis media and colonization.
 - Costs \$200 - \$300 US dollars/child for the recommended 4 dose series of injections.

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Tuberculosis

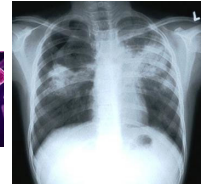
- Someone in the world is newly infected with *M. tuberculosis* every second.
- Left untreated, each person with active TB disease will infect 10-15 people every year.
- People infected with *M. tuberculosis* will not necessarily become sick with the disease.
- 5-10% of people who are infected with *M. tuberculosis* become sick or infectious at some time during their life.



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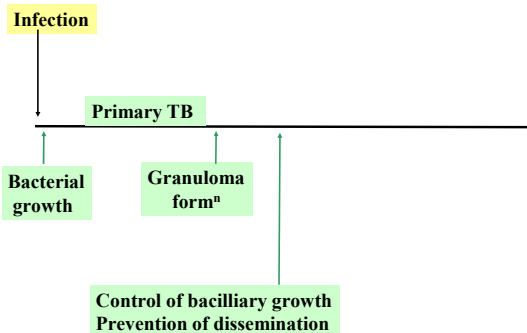
Exemplar: *Mycobacterium tuberculosis*

- **Characteristics**
 - Gram + rods (stain with difficulty)(slow growing) various *Mycobacterium* spp.
- **Diagnosis:**
 - Skin test, chest X-ray, microscopy (sputum smear), culture, PCR
- **Transmission:**
 - Individuals with secondary TB highly contagious, spread by respiratory droplets
- **Pathogenesis:**
 - Infection of the lower lung
- **Treatment and prevention:**
 - Antibiotics (limited)
 - Vaccination



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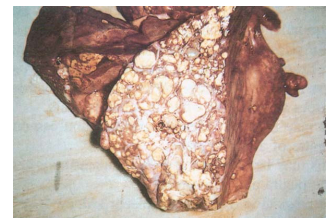
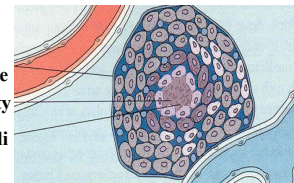
Stages of *M. tuberculosis* persistent infection



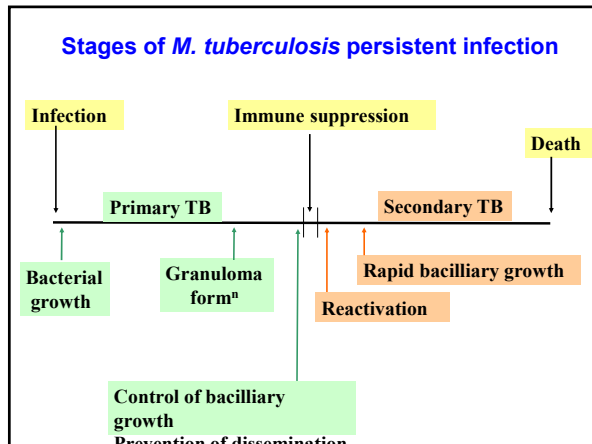
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Granuloma

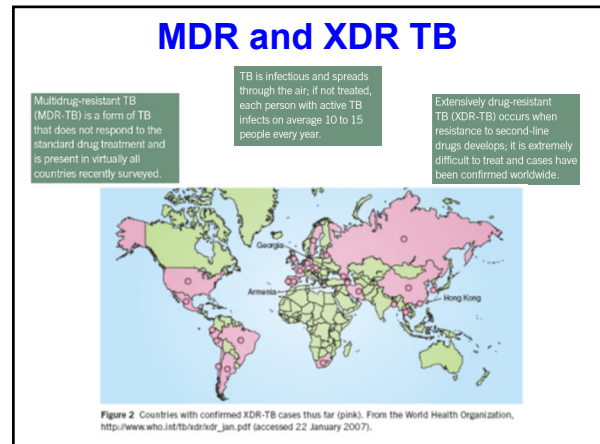
Outer layer of mature tubercule
Tuberculous cavity
Tubercule bacilli



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Tuberculin skin test

- Diagnosis of latent or clinically undeclared TB
- Most useful in countries with low disease incidence
- +ve test after recent -ve indicates recent exposure
- Injection of proteins made by *M. tuberculosis* (tuberculin)
- Purified protein derivative (PPD) derived from broth cultures
- Mantoux test: most accurate, delivers defined dose

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Exceptions

- **False negative reactions**
 - persons recently infected with TB
 - elderly, debilitated and immunocompromised (e.g. AIDS) patients
 - May be unresponsive
 - In some patients, the reaction may be negative even though TB disease is present
- **False positive reactions**
 - may result from exposure to "atypical" mycobacteria, which cause different patterns of infection and disease
 - Important because treatment is different
 - person has been vaccinated

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Prevention of TB

- BCG vaccine (Bacille Calmette-Guerin), available since 1920's
 - Attenuated bovine strain (*M. bovis*)
 - Vaccine used in endemic regions
 - Causes person to convert to positive skin test
 - Not used in countries with low incidence of TB

Pros: Low cost, effective in young children.

Cons: variation in potency of live vaccines, variation in effectiveness among adults, potential for disseminated BCG in HIV infected individuals, effect on skin test reaction to tuberculin.

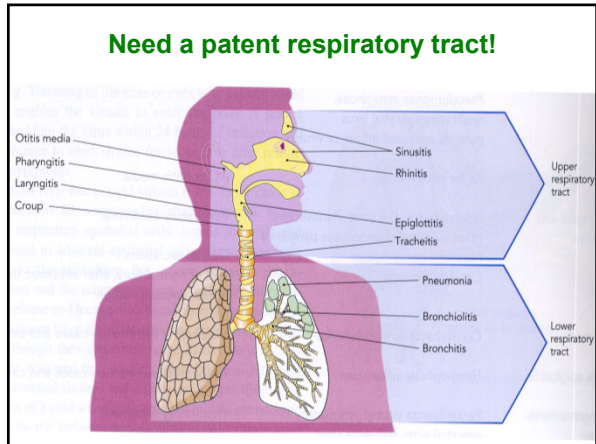
- Elimination of disease highly unlikely
- Control by active surveillance, intervention & monitoring

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Lower respiratory tract infections

Disease	Infecting organisms	Comments
Bronchitis Bronchiolitis	Respiratory viruses, esp. RSV, influenza, adeno & rhinoviruses <i>Mycoplasma pneumoniae</i> , <i>Streptococcus pyogenes</i>	Malaise, headache, sore throat, fever cough (non-productive or mucopurulent), supportive therapy
Whooping cough	<i>Bordetella pertussis</i>	mucus - inspiratory stridor (whoop) toxin, tissue damage vaccination available
Influenza	Orthomyxoviruses	Haemagglutinin/Neuramidase proteins genetic mixing (bird/human in pig) variable symptoms (bronchitis-pneumonia)
Pneumonia	<i>Streptococcus pneumoniae</i> <i>Haemophilus influenzae</i> <i>Mycoplasma pneumoniae</i> <i>Chlamydia pneumoniae</i>	typical/atypical disease, acute illness radiological shadowing, respiratory distress community-acquired (CURBS), nosocomial, ventilator, immunosuppressed
Tuberculosis (TB)	<i>Mycobacterium tuberculosis</i>	primary TB, granuloma, secondary TB skin test, vaccination multi-drug resistance (extensively DR)

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