Respiratory infections

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Layout

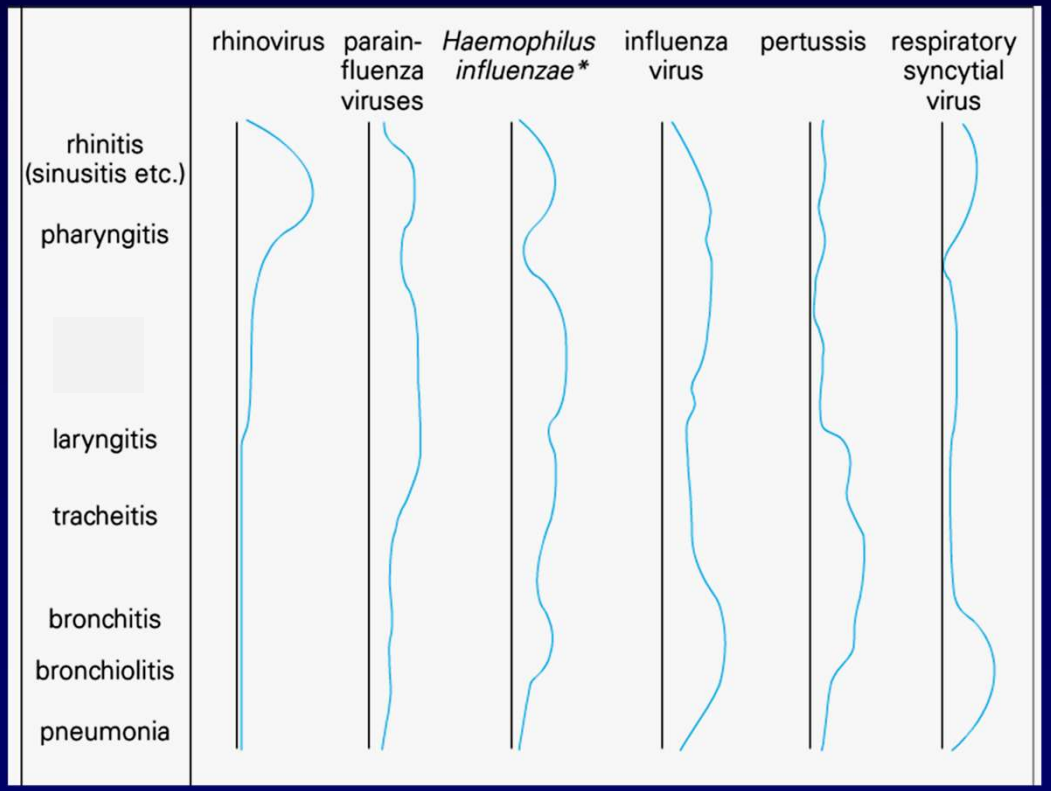
- Introduction
- Material for investigation, examination methods
- Major pathogens
- Upper airway infections
- Lower airway infections
    - community acquired pneumonia
        - typical agents
        - atypical agents (bacterial, viral)
    - hospital acquired pneumonia

Other: chronic infections, immunocompromised

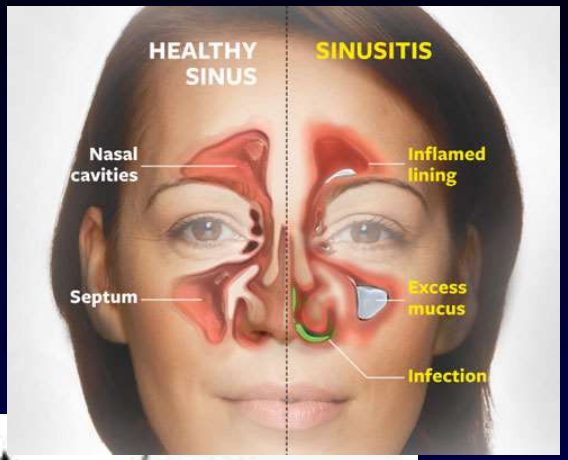
- most common infections worldwide
- often epidemic outbreaks: droplet transmission; direct contact
  seasonal pattern

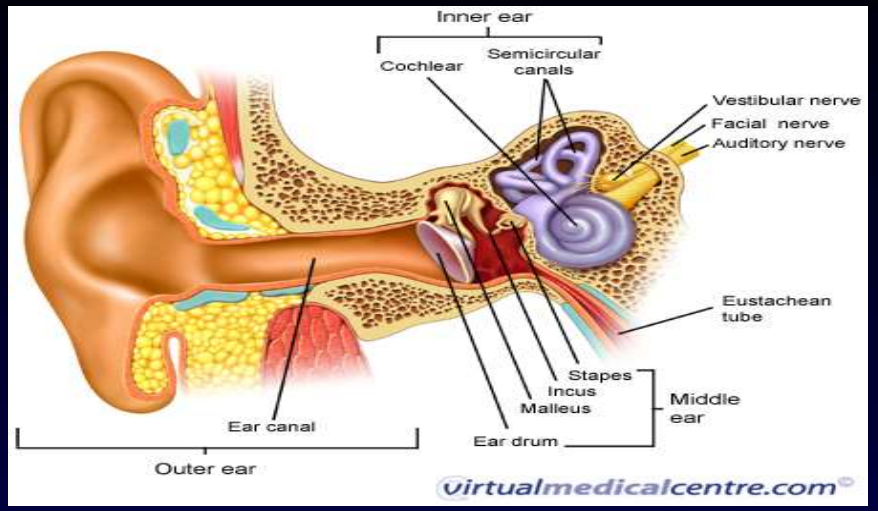
- acute or chronic
- community acquired or nosocomial

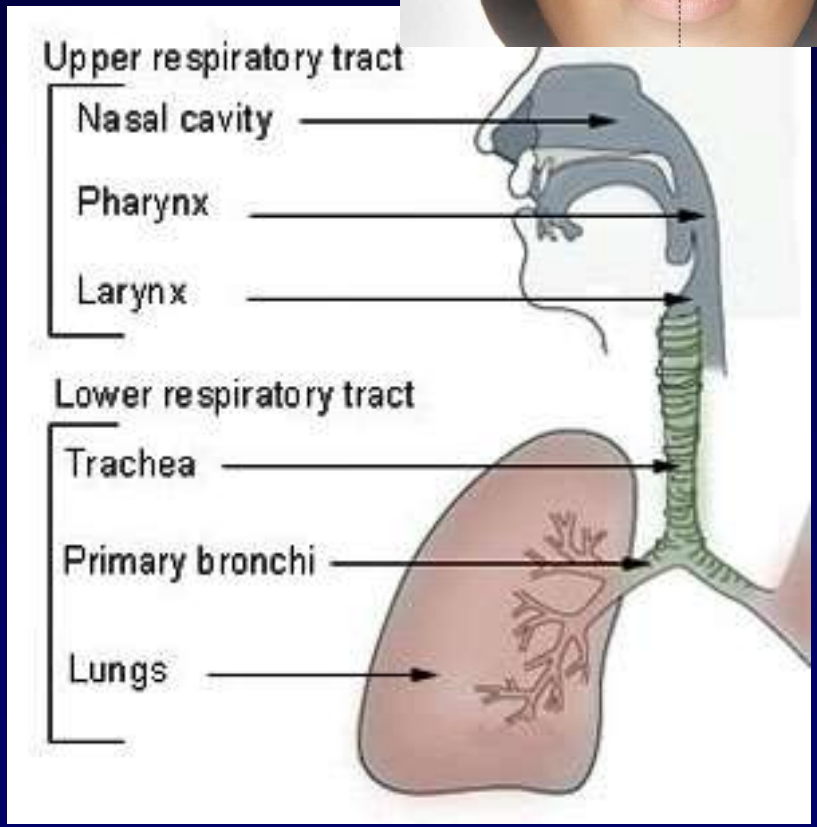
- bacterial or viral (with the risk of bacterial superinfection) ... or fungal
  - the same microorganism can cause different diseases
  - from mild to life threatening



Respiratory tract: anatomy







Conductive zone:

Cilia, mucus (submucosal glands)

Anaerobic growth conditions
- inside sputum

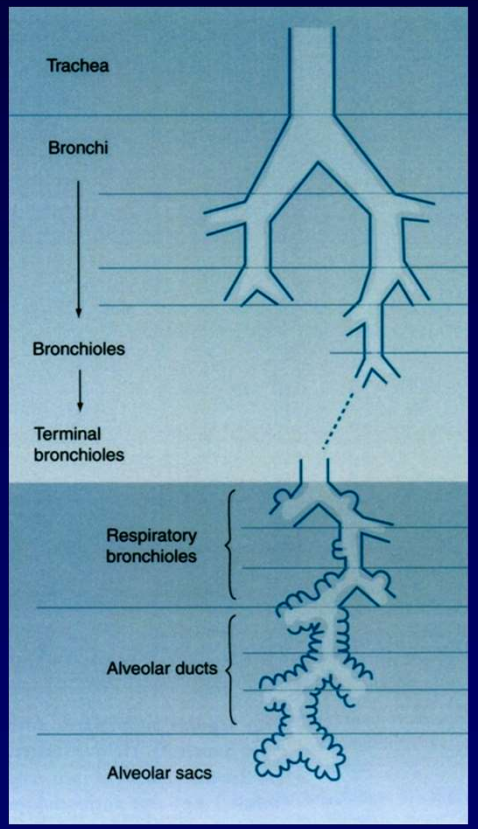
Targeted with inhaled antibiotics

Respiratory zone:

No cilia, no mucus

Mostly aerobic growth conditions

Targeted with systemic antibiotics

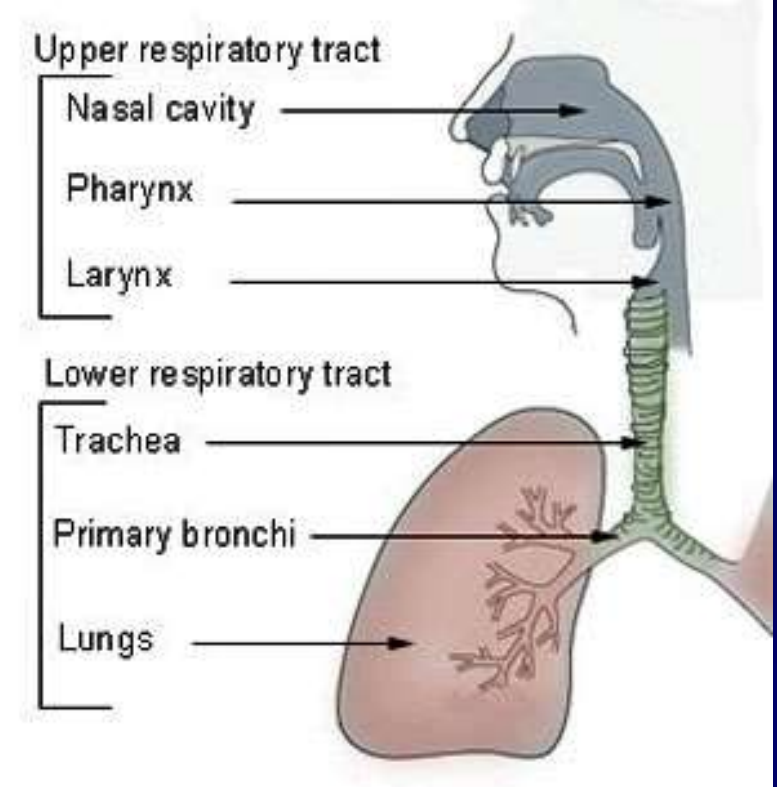


Respiratory tract: one of important ports of entry

- some infections remain there
- some spread further
    - per continuitatem (*S. pneumoniae*)
    - via blood (*S. pneumoniae*, TB, measles)
    - systemic effect of toxin (scarlet fever, diptheria, pertussis)

Respiratory tract: naturally colonized

- not every bug means infection (microbiota)



• staphylococci, diphteroids, *S. aureus*

• *H. influenzae*, *S. pneumoniae (*over 50% of children), viridans streptococci, neisseria, meningococci, enterobacteria, candida

• Lung microbiome: streptococci, haemophilus, anaerobes, pseudomonads …..

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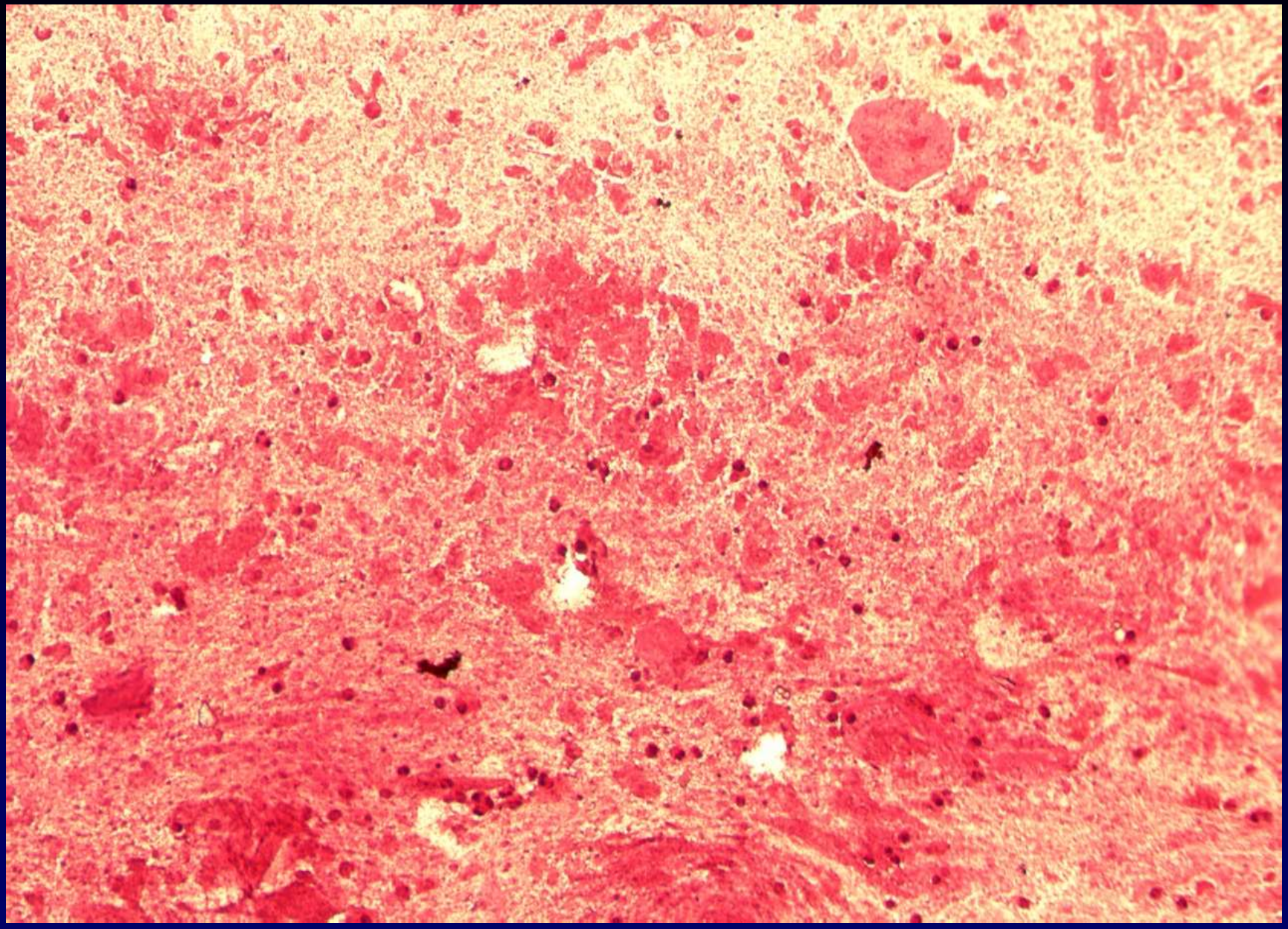
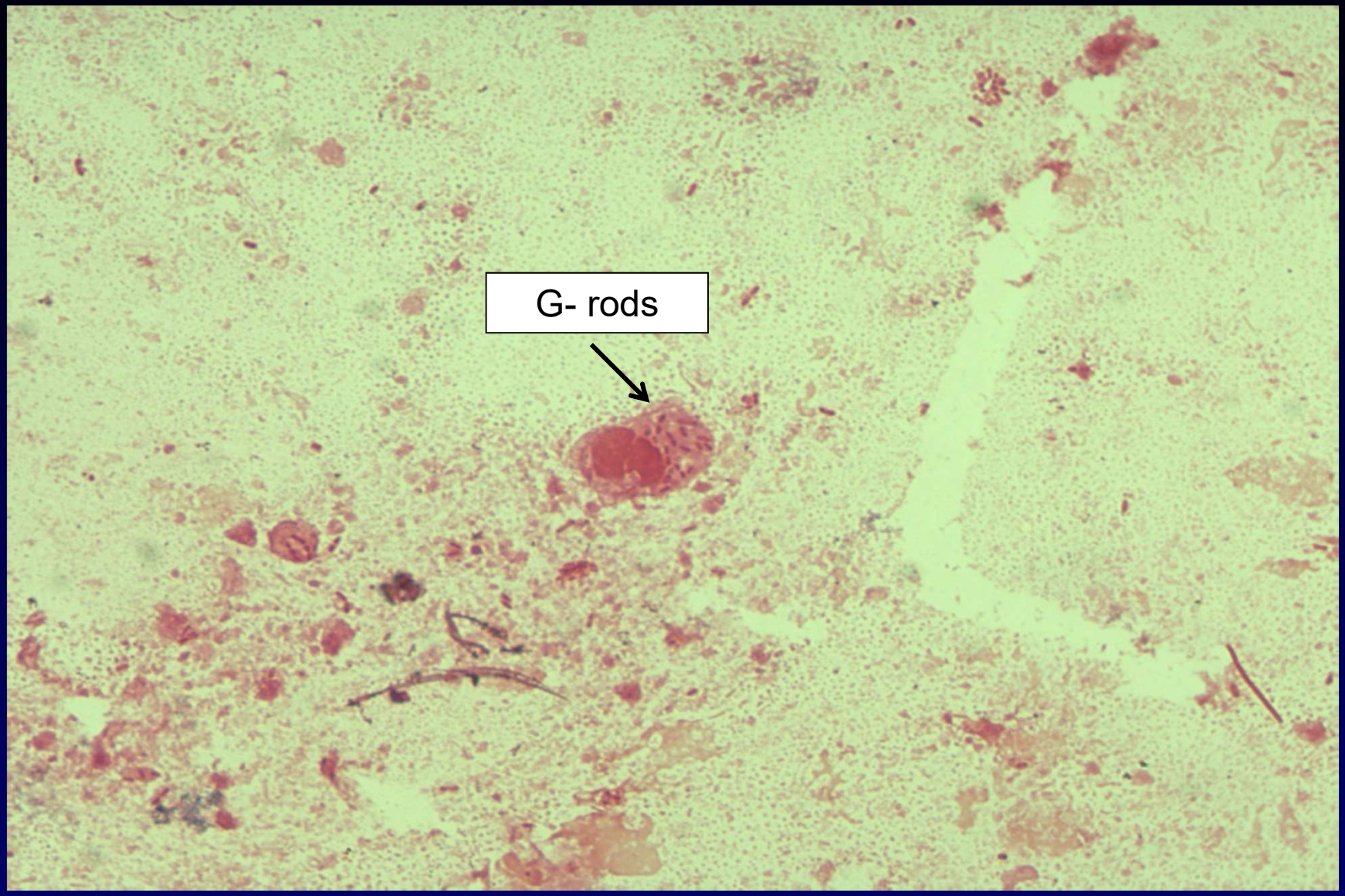
Suitable material for investigation

- SPUTUM

 - microscopy (to validate sputum)



zoom 10x10



zoom 10x100

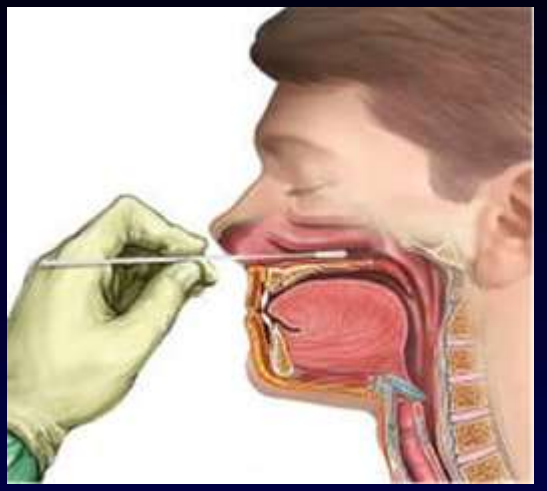
Suitable material for investigation

- SPUTUM

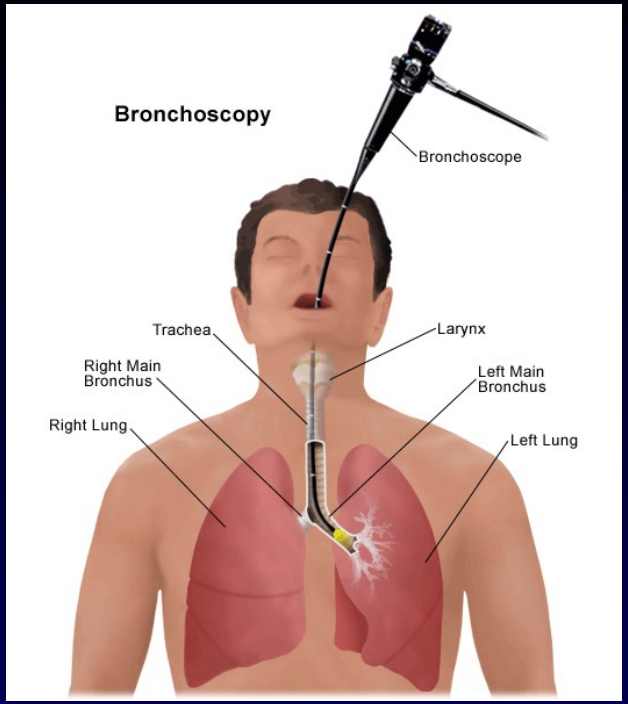
  - microscopy (to validate sputum)
  - culture (incl. quantification)
  - molecular genetics

- Induced sputum

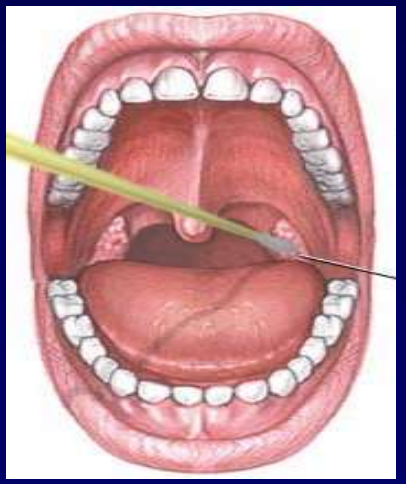
- nasopharyngeal swab
  - viral dg. (PCR, Ag)
  - pertussis, atypical pathogens



- bronchoalveolar lavage (BAL)
  - microscopy, culture, PCR
  - Ag of molds



- throat/cough swab
  - culture
  - Ag (Strep test)



- urine
  - pneumococcal Ag (in children low PPV)
  - legionella Ag

- serum
  - mold Ag (glucan; galactomannan ~ aspergillus)
  - antibodies (chlamydia, mycoplasma, pertussis, flu)

- blood cultures

- pleural fluid

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Key players

Viruses, called respiratory viruses:

orthomyxoviruses: influenza A, B

paramyxoviruses: parainfluenza PIV 1 to 4, RSV,
metapneumovirus hMPV, measles

picornaviruses: rhinovirus HRV; coxsackie and echovirus (= enteroviruses!)

adenoviruses

coronaviruses HCoV

Key players

Bacteria:

S. pneumoniae
H. influenzae
C. pneumoniae
M. pneumoniae
S. aureus
L. pneumophila
M. tuberculosis, NTM

B. pertussis, B. parapertussis
C. diphteriae

Nosocomial infections:
P. aeruginosa
other G- non-fermenters
enterobacteria

Fungi: *Aspergillus* spp., *Pneumocystis jiroveci*

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Rhinitis

• rhinoviruses (also others – e.g. coronaviruses, coxsackie)
mucoid secretion is not a sign of bacterial infection

What do the different snot colors mean?

	clear	white	green or yellow	red or pink	brown or orange	black
"normal" or healthy	✓					
allergic sinusitis	✓					
common cold		✓	✓			
fungal infection						✓
injury or irritation				✓	✓	
nonallergic or pregnancy rhinitis	✓			✓		
sinusitis		✓				
smoking/drug use						✓

Sinusitis, otitis media

- viruses
- *S. pneumoniae*, *H. influenzae*, *M. pneumoniae*, *M. catarrhalis*, anaerobes

otitis in young children
complications - mastoiditis, risk of meningitis

Th: amoxicillin

Tonsillopharyngitis (sore throat)

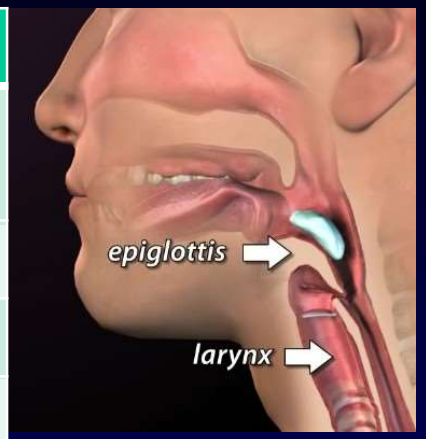
- adenoviruses (often accompanied with conjuctivitis)
- EBV (part of inf mononucleosis)
- *S. pyogenes* (5-15 yrs of age)
- streptococci groups C, G
- *Arcanobacterium heamolyticum*
- *N. gonorrhoeae*

complications in GAS
scarlet fever (when exotoxin is produced)
rheumatic fever (alteration of mitral valve, arthritis, chorea minor, erythema)
glomerulonephritis
peritonsillar abscessus

Th: GAS: PNC V for 10 days
Arcanobacterium: macrolides

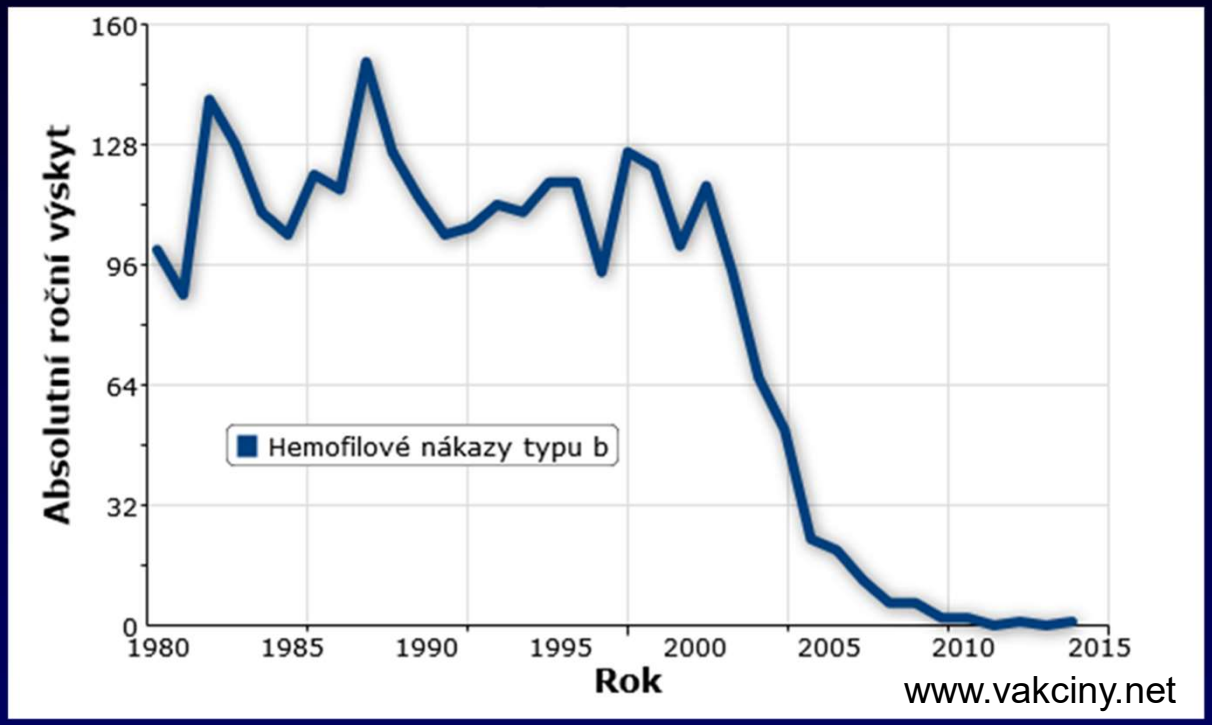
epiglottitis versus laryngitis (subglotic laryngitis, laryngotracheitis)

Epiglottitis	Croup, pseudocroup
H. influenzae type b	viruses (parainfluenza)
rapid onset	upper airway infection
no cough	barking cough
fever above 38 deg. C	temp below 38 deg. C
no swallowing	
anxiety	
blood cultures	
swab from epiglottis questionnable	
ATB th! aminoPNC, cephalosporins II., III. gen.	



Invasive *H. influenzae* type b in CR

1999: 54x meningitis, 36x epiglottitis, 6x sepsis, 5x pneumonia



BUT: other serotypes of *H. influenzae* still out there

H. influenzae non-typeable, types e, f

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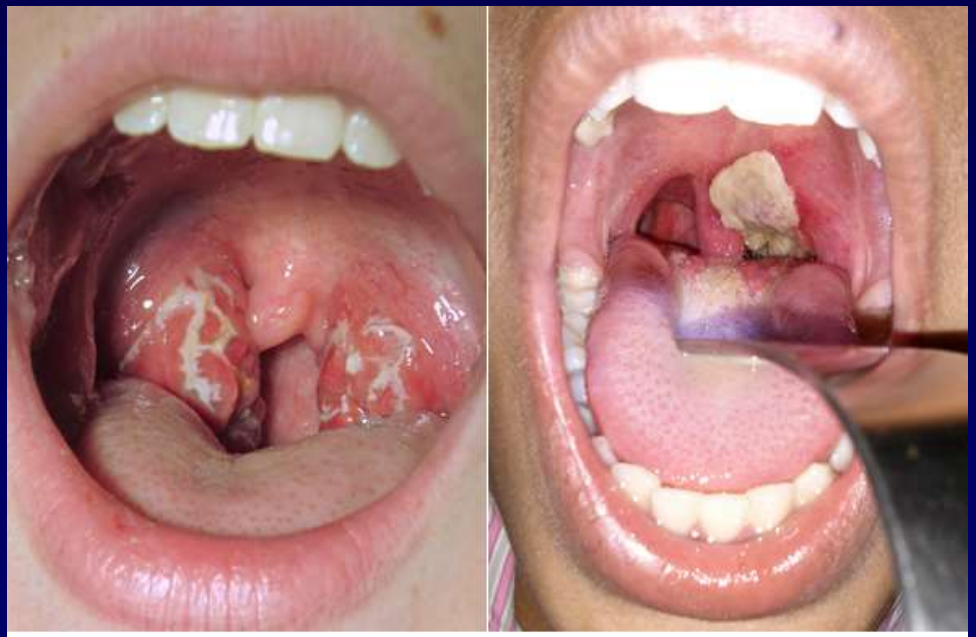
Diphteria

Corynebacterium diphteriae (and other corynebacteria) with production of the toxin (the evidence by PCR)

- tonsillitis, pharyngitis
- laryngitis (true croup) with production of pseudomembranes

- myocard alteration
- neurological problems



Tonsillitis Diphtheria

Pertussis

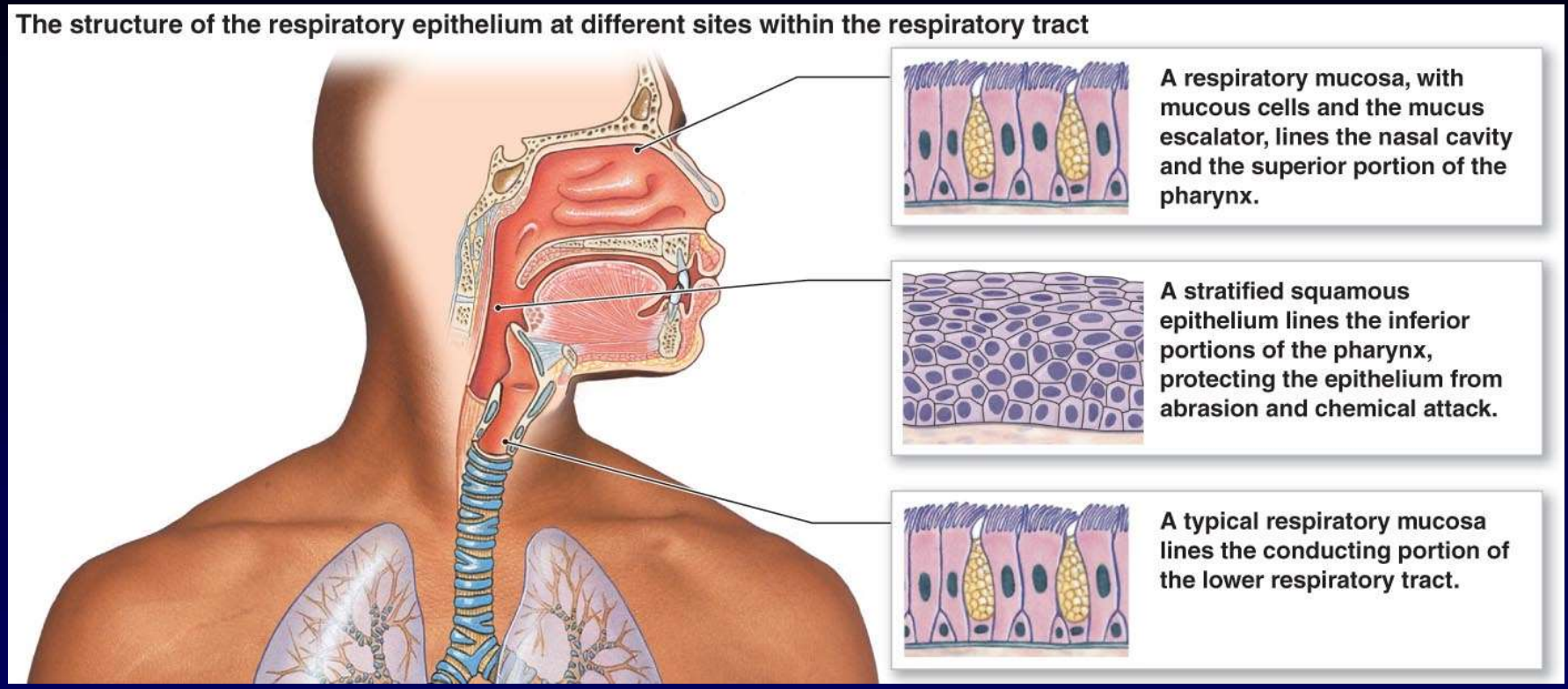
Bordetella pertussis, B. parapertussis

Disease stages:

- catarrhal (common cold)
- paroxysmal (paroxysmal cough, dyspnoe, vomiting)
- convalescent (risk of secondary infections, encephalopathy)

- today more likely atypical course (persistent cough in adults)
- in infants (non-vaccinated) a risk of malignant pertussis:
    - respiratory failure
    - leukocytosis and right-sided heart failure
    - encephalopathy

Dg: culture, PCR, serology



non-invasive disease affecting ciliated epithelium

→ nasopharyngeal swab, aspirate

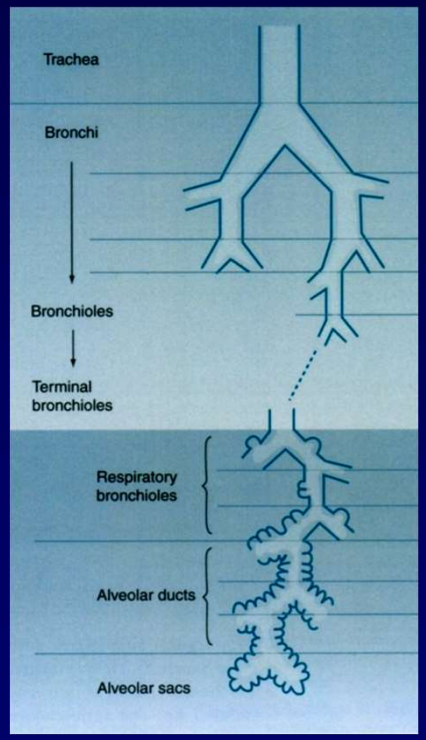
Bronchiolitis (obliterans)

respiratory syncytial virus RSV-A, RSV-B

- in children below 2 years of age (high risk in preterm babies by 6 mo of age)
- serious condition

Th: ribavirin
+ passive immunization (Ab against F protein)

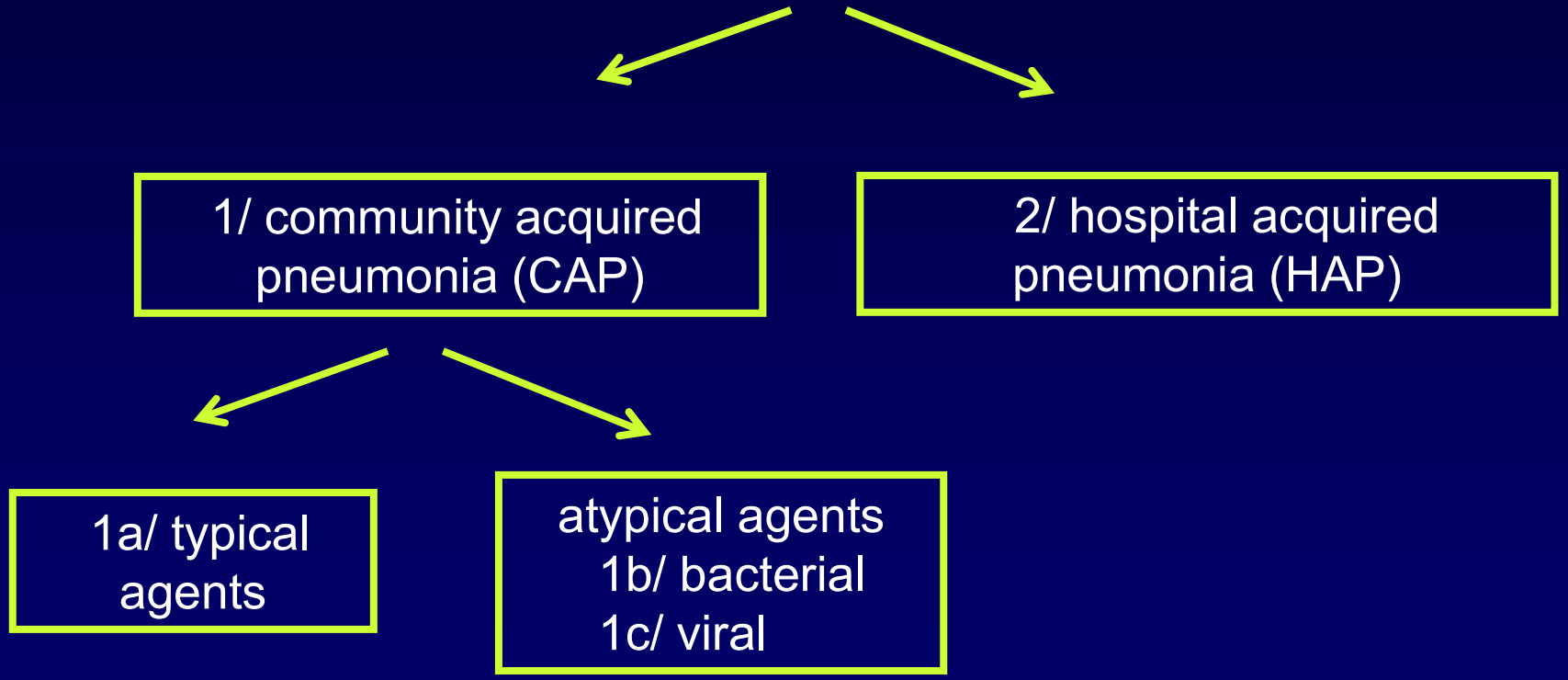
= also as prevention
for infants at risk in winter months



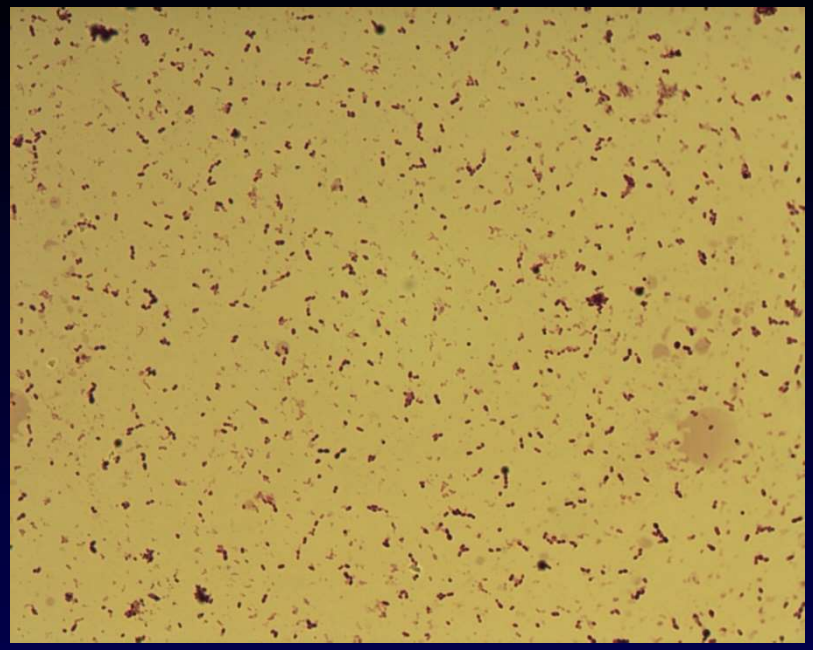
Pneumonia

• infectious condition with corresponding respiratory symptomatology (cough, tachypnoe, dyspnoe, …) and the fresh radiological finding on lungs

• inflammation affecting alveoli, respiratory bronchioli (bronchopneumonia), or also interstitium



1a/ CAP with typical pathogens



- *S. pneumoniae* (most common)
- *H. influenzae*
- *Moraxella catarrhalis*
- *S. aureus* (secondary pneumonia; production of PVL)
- *K. pneumoniae, E.coli*

Diagnostics: direct methods

- sputum
  - microscopy, culture
  - PCR occasionally

- detection of pneumococcal antigen in urine

- blood cultures

1b/ CAP with atypical pathogens

sometimes termed atypical pneumonia, walking pneumonia,
several weeks cough

- *Mycoplasma pneumoniae*: former primary atypical pneumonia
- *Chlamydophila pneumoniae*
- *Chlamydophila psittaci*: psittacosis
- *Coxiella burnetii*: Q fever

Diagnostics: indirect methods
- serology; careful interpretation (up to 80% prevalence in healthy)

direct method - PCR

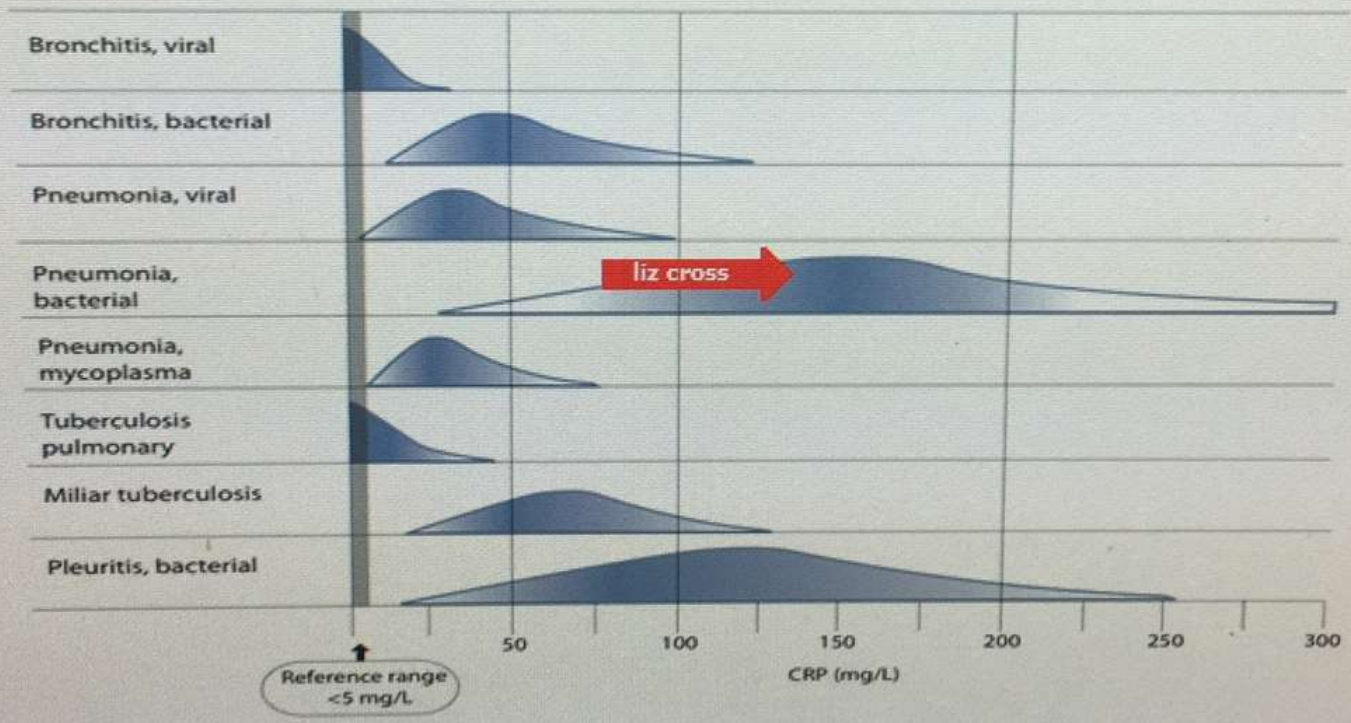
24-year-old lady

5 days fever 40 ^{o}C, vomiting
3 days cough, with sputum, dyspnoea

X ray: small infiltrates on the bottom right
WBC 8.2x10^{9} /l
CRP 153 mg/l

CRP LEVELS IN LOWER RESPIRATORY TRACT INFECTION

Typically higher values in bacterial infections than in viral infections



24-year-old lady

Microbiology:

urine:

antigen *S. pneumoniae* neg.
antigen *L. pneumophila* neg.

nasopharyngeal swab:

M. pneumoniae	****
C. pneumoniae	neg
C. psittaci	neg
L. pneumophila	neg
P. jiroveci	neg

7 days since the start of therapy with fluorochinolons:
mild cough, no temperature
CRP 12.3 mg/l
X ray: substantial regression of the infiltrates

1b/ CAP with atypical pathogens

- *Legionella pneumophila*
  - pontiac fever (mild infection, not pneumonia)
  - Legionnaire's disease

Legionella pneumophila

Diagnostics:
- detection of legionella antigen in urine
- culture
- PCR

- serology

Avoiding Legionnaires' this spring

Spring is a great time to be out in the garden, but it's also important to take care of yourself when handling potting mix and compost to prevent Legionnaires' disease. Here are five easy things you can do:

1. Open potting mix or compost bags carefully with scissors.
2. Wear a well-fitting disposable face mask and gloves.
3. Reduce dust by dampening down potting mix or compost.
4. Work with potting mix or compost in a well-ventilated area outside.
5. Wash your hands after handling potting mix or compost and before removing your mask.

Legionella longbeachae

ATB therapy of CAP

Pneumococcal pneumonia:

non complicated - amoxicillin (not hospitalized)
hospitalization - PNC G or cephalosp. III. gen.

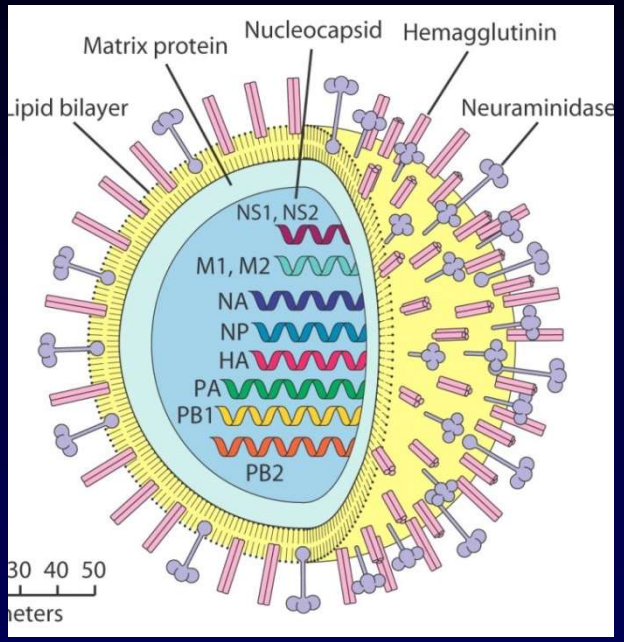
Atypical agents:

macrolides
tetracyclines
respiratory fluoroquinolons (moxifloxacin)

1c/ CAP with atypical pathogen - virus

Influenzavirus type A, B, C

subtypes HxNx (H1N1, H3N2)



Spanish flu 1918 - 1919

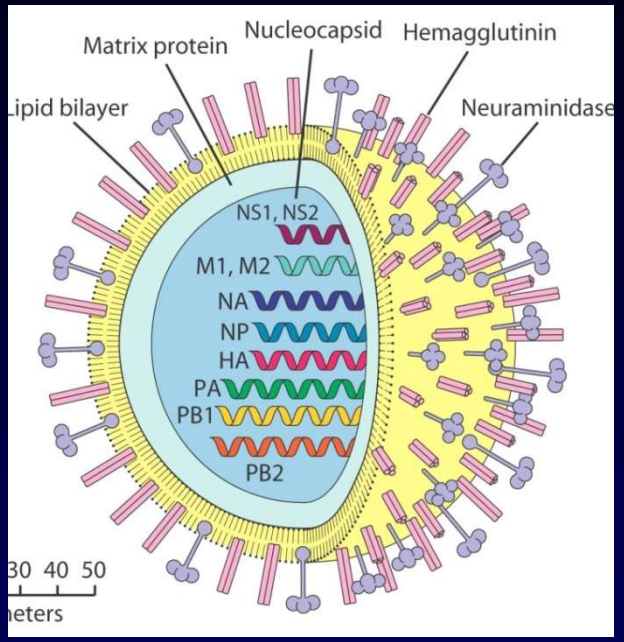
20 - 50 mil. deaths

The Family, 1918 Egon Schiele

1c/ CAP with atypical pathogen - virus

Influenzavirus type A, B, C

subtypes HxNx (H1N1, H3N2)



- tracheobronchitis
- pneumonia
  - primary viral
  - secondary bacterial

Diagnostics:

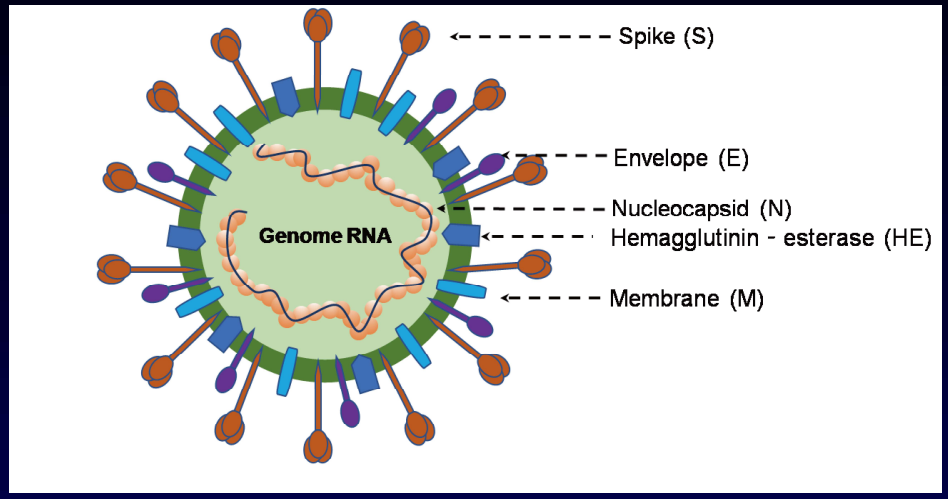
- antigen detection (low sensitivity)
- PCR

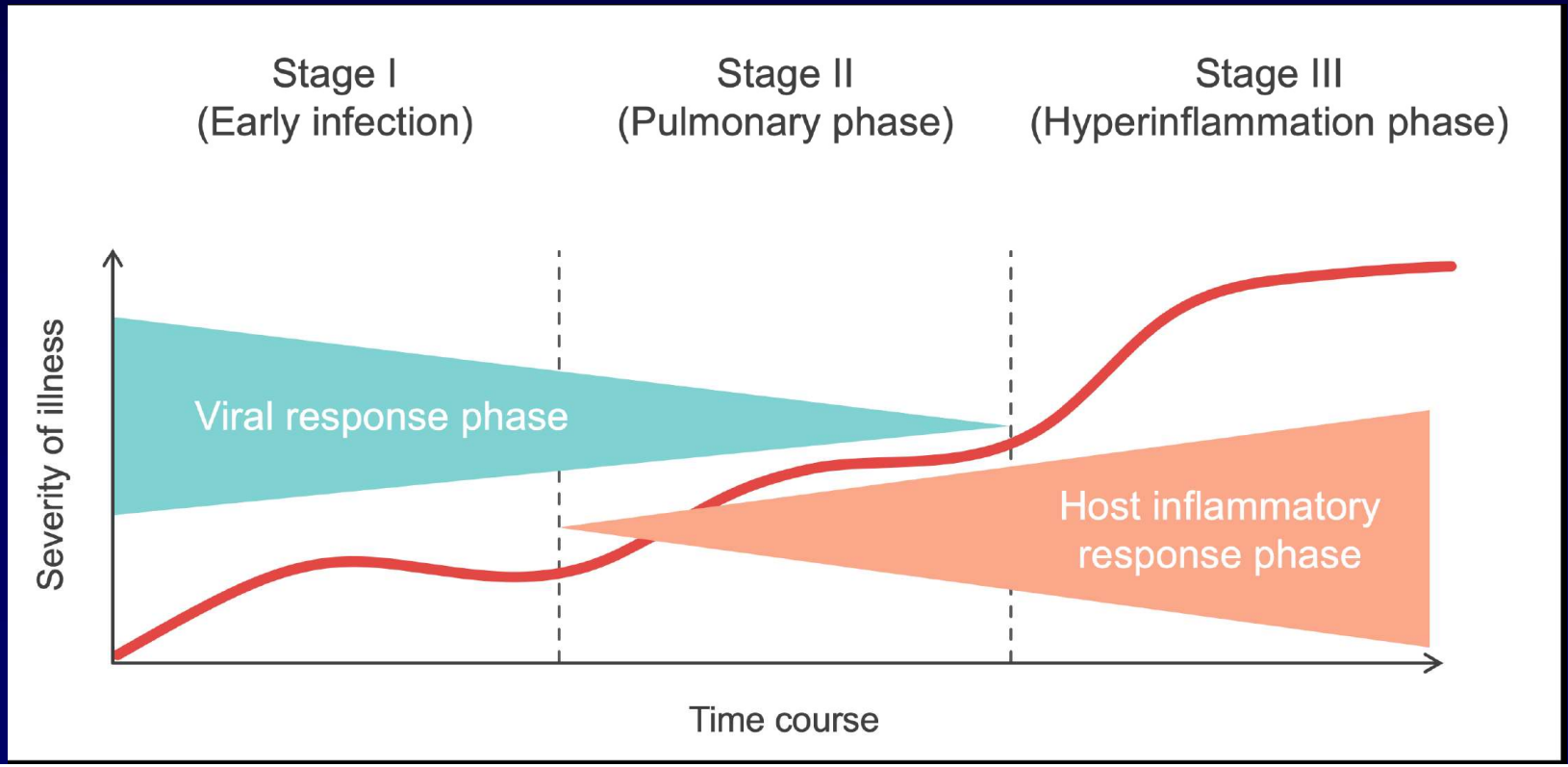
- serology

1c/ CAP with atypical pathogen - virus

SARS-CoV-2

- asymptomatic course
- pneumonia

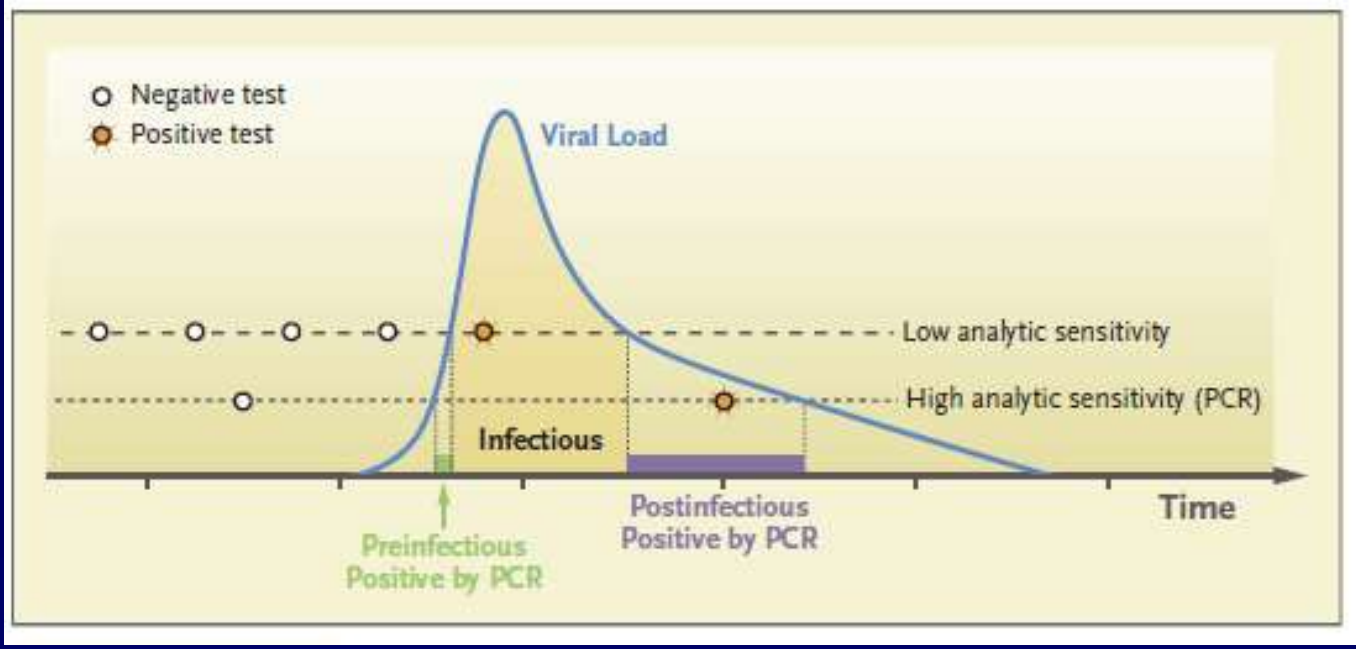




1c/ CAP with atypical pathogen - virus

SARS-CoV-2

- Direct detection
  antigen
  RNA
- Indirect detection
  IgM, IgA, IgG



SARS-CoV-2: PCR a virus variants in clinical practice

Swab from nasopharynx

standard

statim

RNA isolation

GeneXpert: 60 min

ID Now: 15 min

diagnostic PCR

positive

discriminatory PCR

on average 50.000 tests per day

2/ HAP; hospital acquired pneumonia

develops min. 48 hours post admission and in association with hospitalization
typically of bacterial origin

Ventilator associated pneumonia (VAP)

Early onset (by day 5)

- *S. aureus*
- *S. pneumoniae*
- *H. influenzae*
- *K. pneumoniae, E. coli*

Late onset

- *K. pneumoniae, E. coli …*
- *P. aeruginosa*
- MRSA
- *A. baumannii*

Diagnostics: endotracheal aspirate

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Newborn pneumonia

- *S. agalactiae* GBS
- *Chlamydia trachomatis*

- *K. pneumoniae, E. coli*

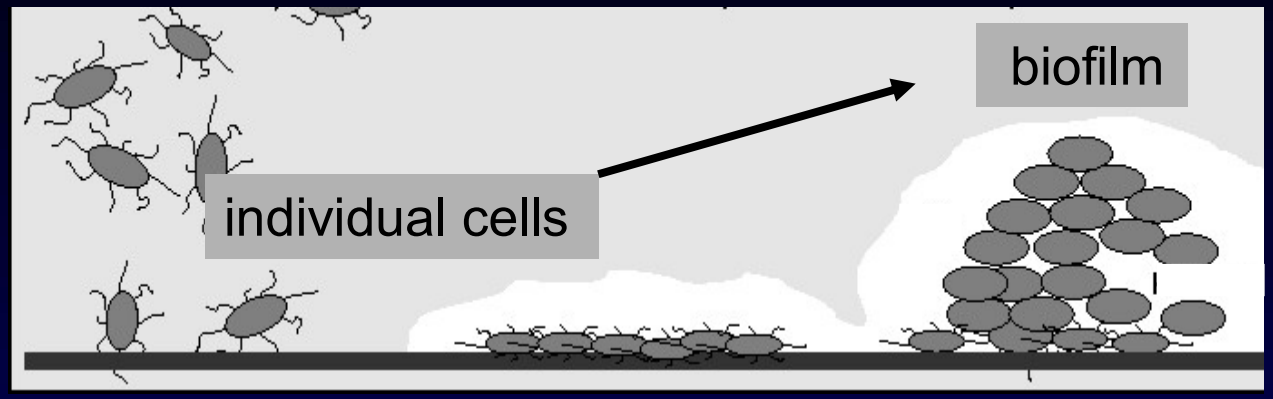
Chronic respiratory diseases and chronic infections

- chronic obstructive pulmonary disease (COPN)
- chronic bronchiectasis
- cystic fibrosis (mucoviscidosis)

- *S. aureus*
- enterobacteria (*K. pneumoniae*)

- G- nonfermenters
  - *P. aeruginosa*
  - complex *Burkholderia cepacia*
  - *Stenotrophomonas maltophilia*
  - *Achromobacter xylosoxidans*

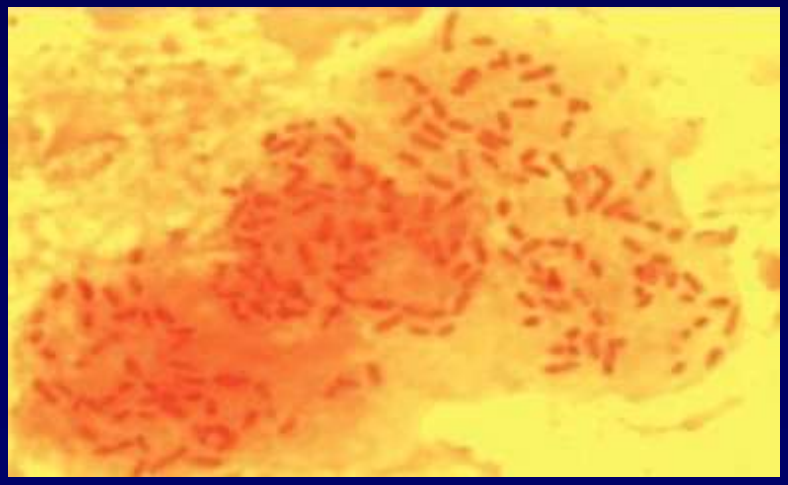
Infection course



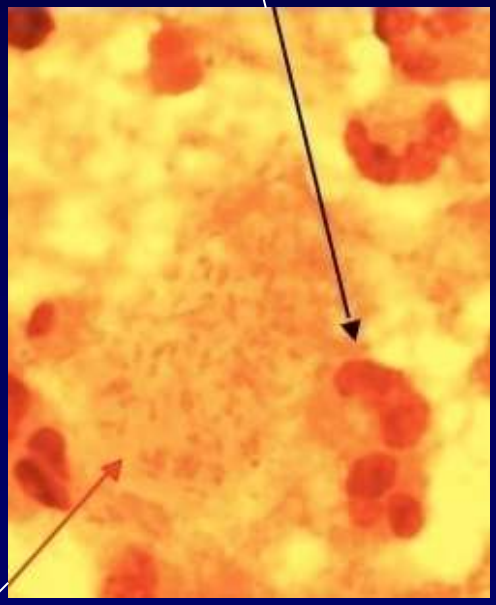
Biofilm

- Aggregate of bacteria embedded in matrix which they produce themeselves (polysaccharides, proteins, DNA)

- Protection against phagocytosis, ATB



Courtesy: Prof. N. Hoiby, Copenhagen



P. aeruginosa biofilm

Immunocompromised and respiratory infections

- haematological malignancies
- AIDS
- after solid or bone marrow transplantation

Oportunistic pathogens of both endogenous and exogenous origin

- CMV
- TB, NTM
- *Pneumocystis jiroveci*; microscopy, PCR
- fungi

2-month old girl

10 days cough, increased mucus, temperature max. 37.5 °C
x ray: difuse gentle infiltrates

Microbiology:
culture aspirate from upper airways: S. aureus; K. oxytoca

PCR nasopharyngeal swab:

respiratory viruses all neg.

M. pneumoniae neg
C. pneumoniae neg
L. pneumophila neg
P. jiroveci **

BAL:

M. pneumoniae neg
C. pneumoniae neg
L. pneumophila neg
P. jiroveci ****

Therapy:
Ampicillin/sulbactam --> cotrimoxazol