



**BHARATHIDASAN UNIVERSITY**

**Tiruchirappalli-620024**

**Tamil Nadu, India.**

**Programme:M.Sc., Biomedical Science**

**Course Title : Clinical Microbiology**

**Course Code: BM36C9**

**Unit-I**

**General Properties of Medically  
important Bacteria**

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**Guest Lecturer**

**Department of Biomedical Science**

# **General Properties of Medically important Bacteria**

# Bacteria

## Gram positive

### Cocci

Staphylococcus aureus  
Streptococcus pneumonia  
Streptococcus pyogenes

### Rods

Bacillus anthracis  
Bacillus subtilis  
Clostridium tetani  
Clostridium botulinum

## Gram negative

### Cocci

Nisseria meningitis  
Nisseria gonorreha

### Rods

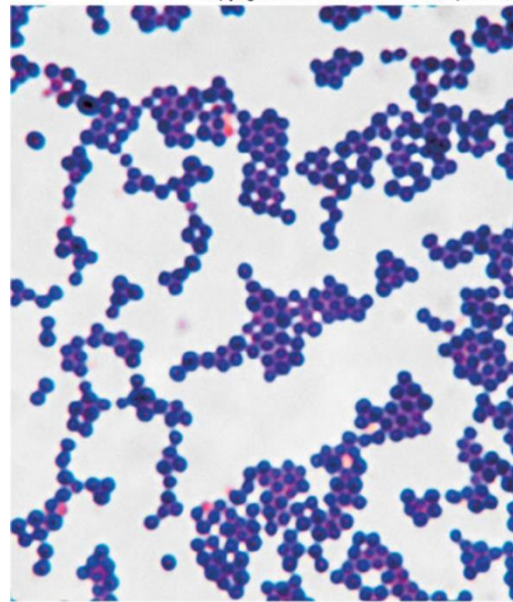
Salmonella typhimurium  
Pseudomonas aeruginosa  
Escherichia coli O157: H7

# Staphylococcus spp

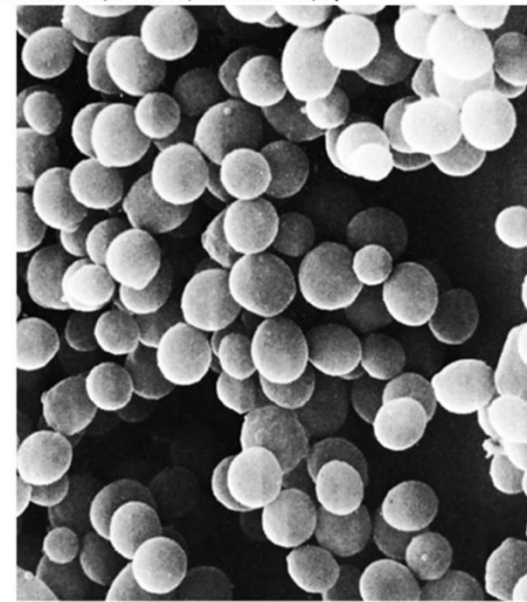
- Family: Micrococcaceae
- Genus:
  - A. Staphylococcus- derived from Greek Include major human pathogen and skin commensals
  - *Staphylococcus* divided into coagulase positive & coagulase negative categories
- Commonspp:
  - *S. aureus*
  - *S. epidermidis*
  - *S. saprophyticus*
  - B. Micrococcus- skin commensal
- Gram-positive spherical cells (0.5-1.5 mm) in singles, pairs, and clusters
- Appear as —bunches of grapes

## *S. aureus*

- ❖ Non motile
- ❖ Non-spore-forming
- ❖ Nonencapsulated
- ❖ Catalase-producing

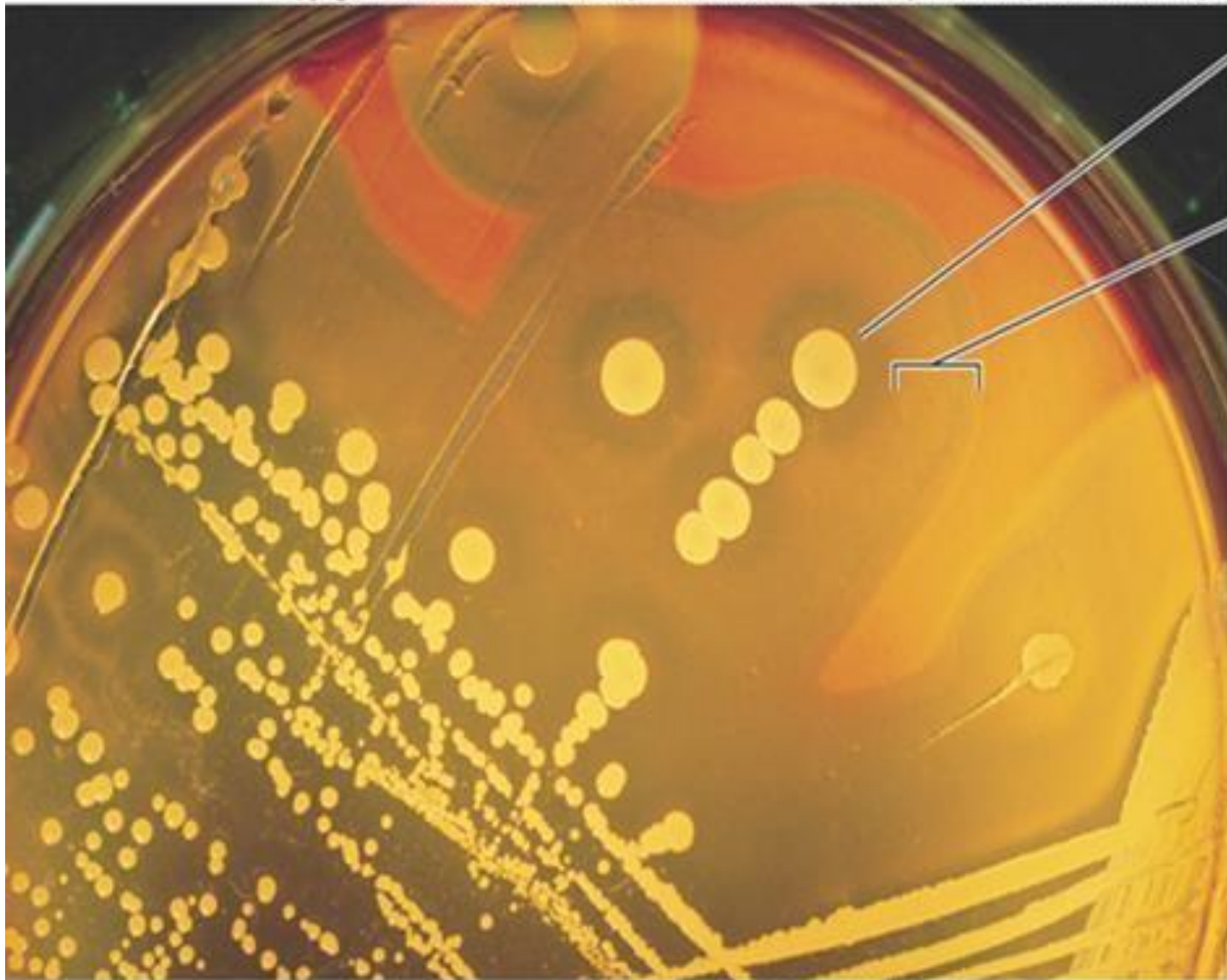


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- ❖ Primarily aerobic, some facultatively anaerobic
- ❖ Inhibited by high bile salt concentration
- ❖ *S. aureus*  $\beta$ -hemolytic
- ❖ Colony morphology:
  - ❖ □ buttery looking, cream or white colored



Beta-hemolysis  
caused by  
 $\alpha$ -toxin

Zone of  
hemolysis  
caused by  
 $\beta$ -toxin

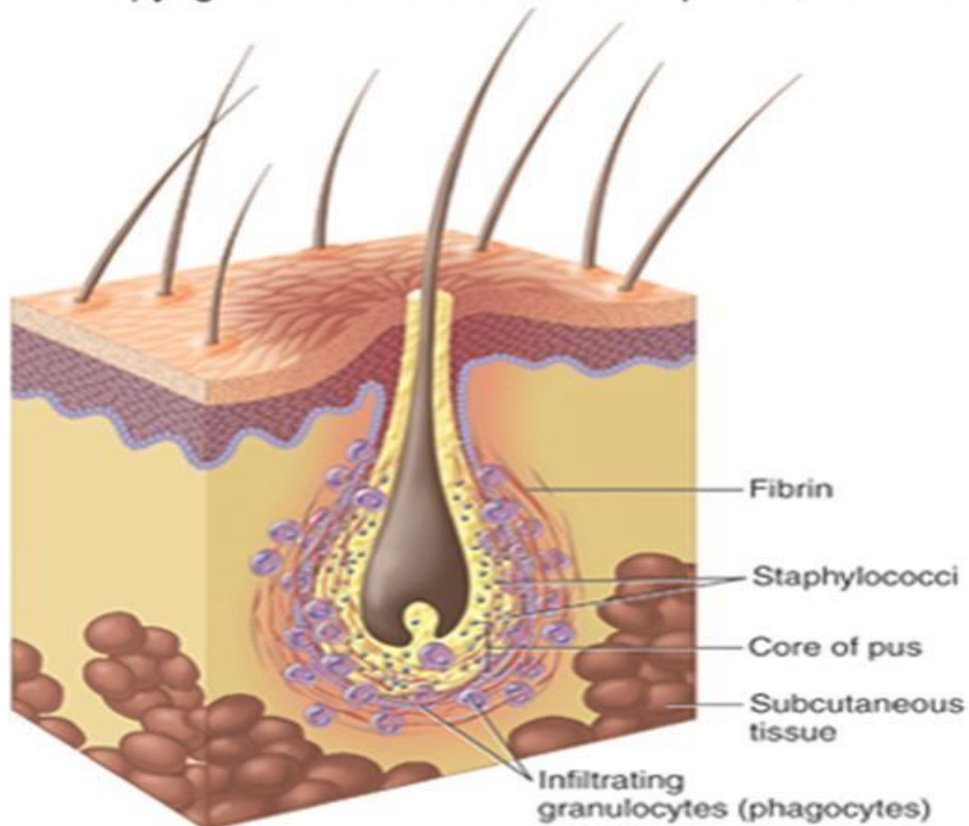
## Virulence factors of *S. aureus*

- ❖ Toxins:
- ❖ Hemolysins ( $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ ) – lyse red blood cells
- ❖ Leukocidin – lyses neutrophils and macrophages
- ❖ Enterotoxin – induce gastrointestinal distress
- ❖ Exfoliative toxin – separates the epidermis from the dermis
- ❖ Toxic shock syndrome toxin (TSST) - induces fever, vomiting, shock, systemic organ damage

# Epidemiology and pathogenesis

- ❖ Present in most environments even humans
- ❖ Readily isolated from fomites
- ❖ Carriage is mostly in anterior nares, skin, nasopharynx, intestine.
- ❖ Predisposition to infection include: poor hygiene and nutrition, tissue injury, preexisting primary infection, diabetes, immunodeficiency.
- ❖ Increase in community acquired methicillin resistance - MRSA





(a) Sectional view of a boil or furuncle, a single pustule that develops in a hair follicle or gland and is the classic lesion of the species. The inflamed infection site becomes abscessed when masses of phagocytes, bacteria, and fluid are walled off by fibrin.



(b) A furuncle on the back of the hand. This lesion forms in a single follicle.

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(c) A carbuncle on the back of the neck. Carbuncles are massive deep lesions that result from multiple, interconnecting furuncles. Swelling and rupture into the surrounding tissues can be marked.

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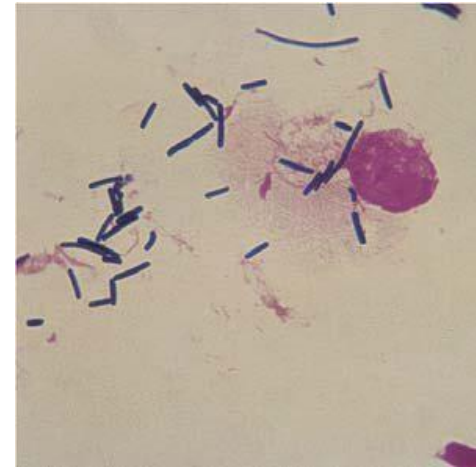
# Other GPC

## # Catalase negative :

- Streptococcus pneumonia* (pneumonia)
- streptococcus pyogenes* (sore throat)
- Streptococcus mutans* (tooth infection)
- Enterococcus faecalis* (GIT + bacteremia)

## Family: Clostridiaceae

- ❖ 3–8 um long, thick, Gram-positive
- ❖ Spore forming, rod shaped bacteria
- ❖ Motile bacteria with flagella
- ❖ strictly obligate anaerobic to aerotolerant
- ❖ Occurrence → naturally inhabit the soil and the intestinal tracts of humans and animals.
- ❖ Common species:
  - ❖ *C. tetani* (tetanus, nervous system disorder)
  - ❖ *C. perfirengens* (anaerobic cellulitis and gas gangrene)
  - ❖ *C. botulinum* (botulism, food poisoning)



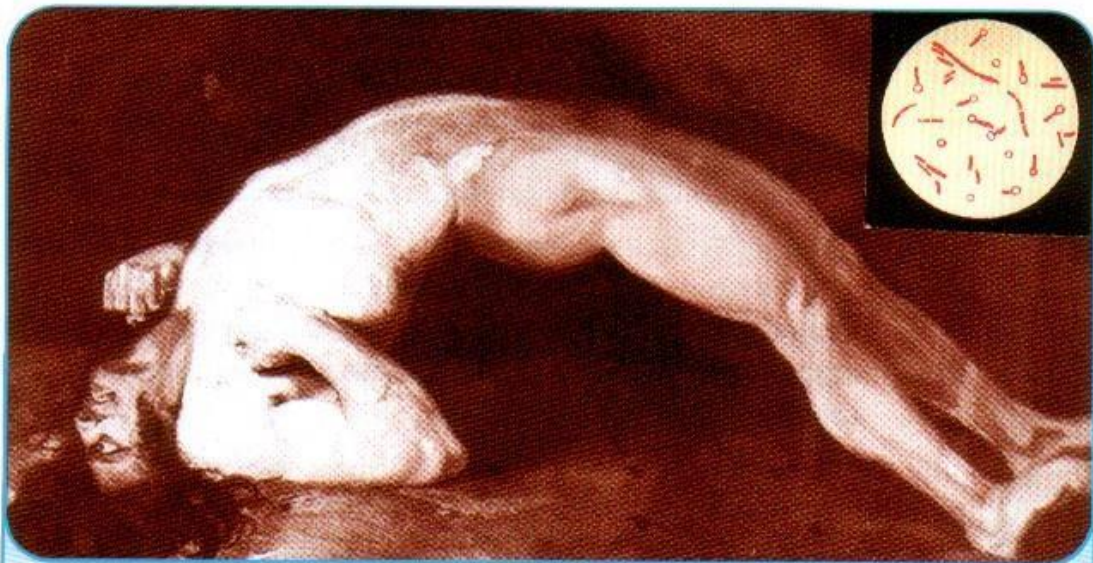
# *C. tetani*

- Tetanus (lockjaw) is an acute clostridial disease,
- its clinical manifestations do not result directly from the invasive infection, but are rather caused by a strong neurotoxin.
- **Pathogenesis and clinical picture.**
- pathogens invade tissues via wounds/ injuries → anaerobic conditions → proliferate and produce the toxin (tetanospasmin) → reaches the anterior horns of the spinal cord or brain stem → spasms of muscles
- ( incubation period : few days to several weeks)

## **Toxin:**

- Tetanospasmin consists of two polypeptide chains linked by a disulfide bridge. The heavy chain binds specifically to neuron receptors.
- The light chain is a zinc-metalloprotease that is responsible for proteolysis
- of components of the neuroexocytosis apparatus in the synapses of
- the anterior horns of the spinal cord. This stops transmission of inhibitory
- efferent impulses from the cerebellum to the motor end plates.





**Рис. 3.79.** Опистотонус



**Рис. 3.80.** Мазок из чистой культуры *C. tetani*.  
Окраска по Граму



# Enterobacteriaceae.

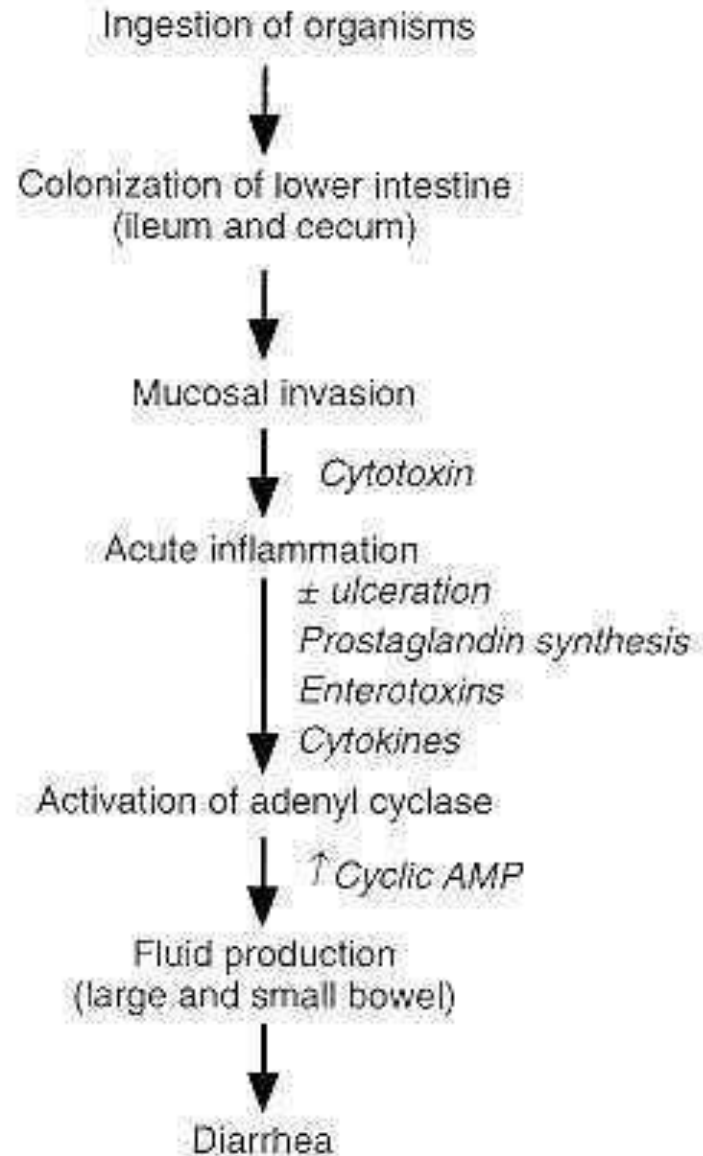
- ❖ 41 genera with hundreds of species
- ❖ Gram-negative,
- ❖ usually motile (peritrichous flagellation or swarming movement)
- ❖ facultative anaerobic rod bacteria
- ❖ natural habitat is the intestinal tract of humans and animals
- ❖ Responsible for nosocomial diseases as well
- ❖ 0.5–1.5  $\mu\text{m}$  thick, and 2–4  $\mu\text{m}$  long
- ❖ Generation time in vitro is 20–30 minutes

## *Salmonella spp*

- ❖ *Salmonella enterica* with seven subspecies.
- ❖ **Typhoid salmonellosis**: typhi and paratyphi A, B, and C
- ❖ Salmonellae are taken up orally and the invasion pathway is through the intestinal tract, from where they enter lymphatic tissue, first spreading lymphogenously, then hematogenously.
- ❖ 1-3 weeks
- ❖ Human carriers are the only source of infection
- ❖ **Enteric salmonellosis** : develop when pathogens are taken up with food. The primary infection source is usually livestock. These relatively frequent infections remain restricted to the gastrointestinal tract.
- ❖ 1–2 days

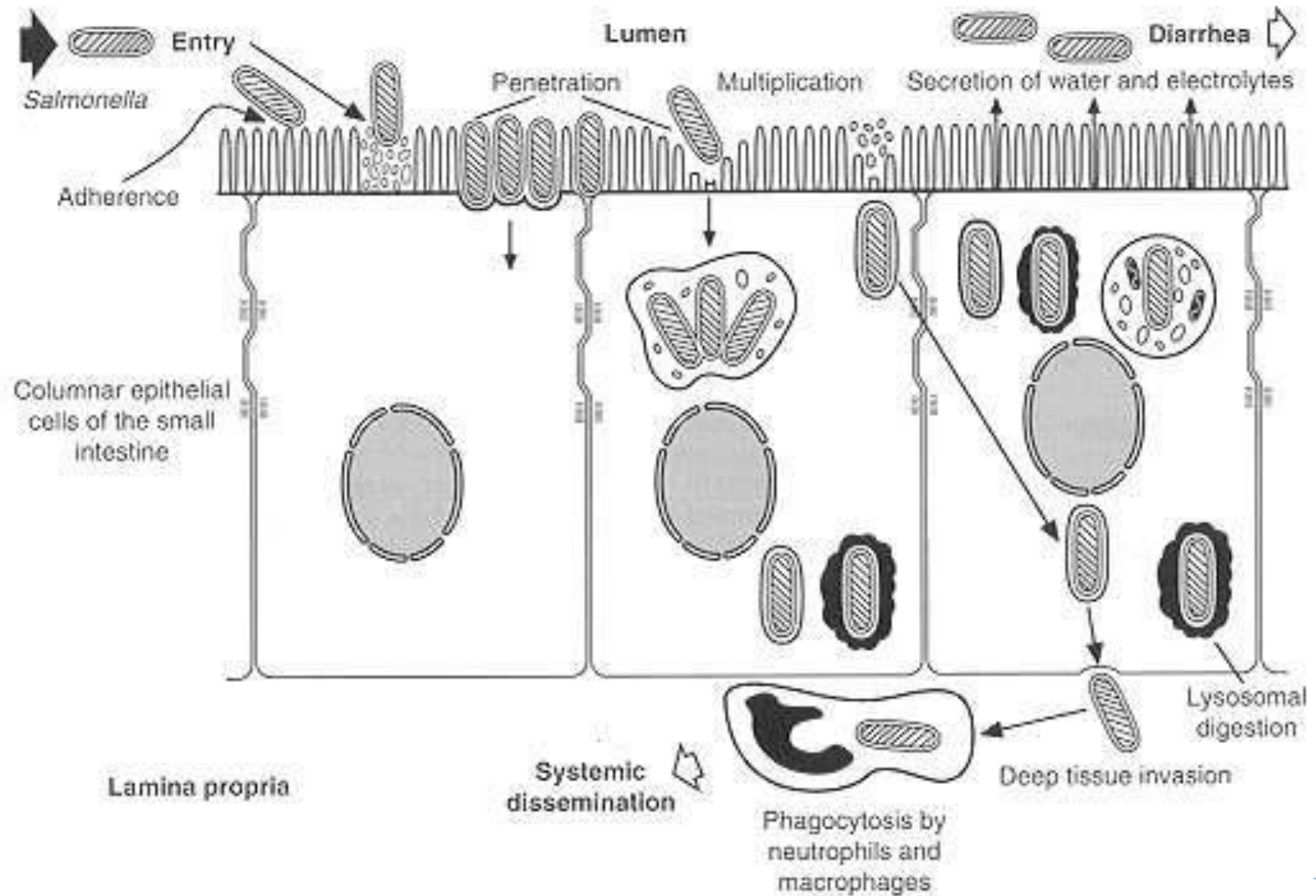
# Pathogenesis

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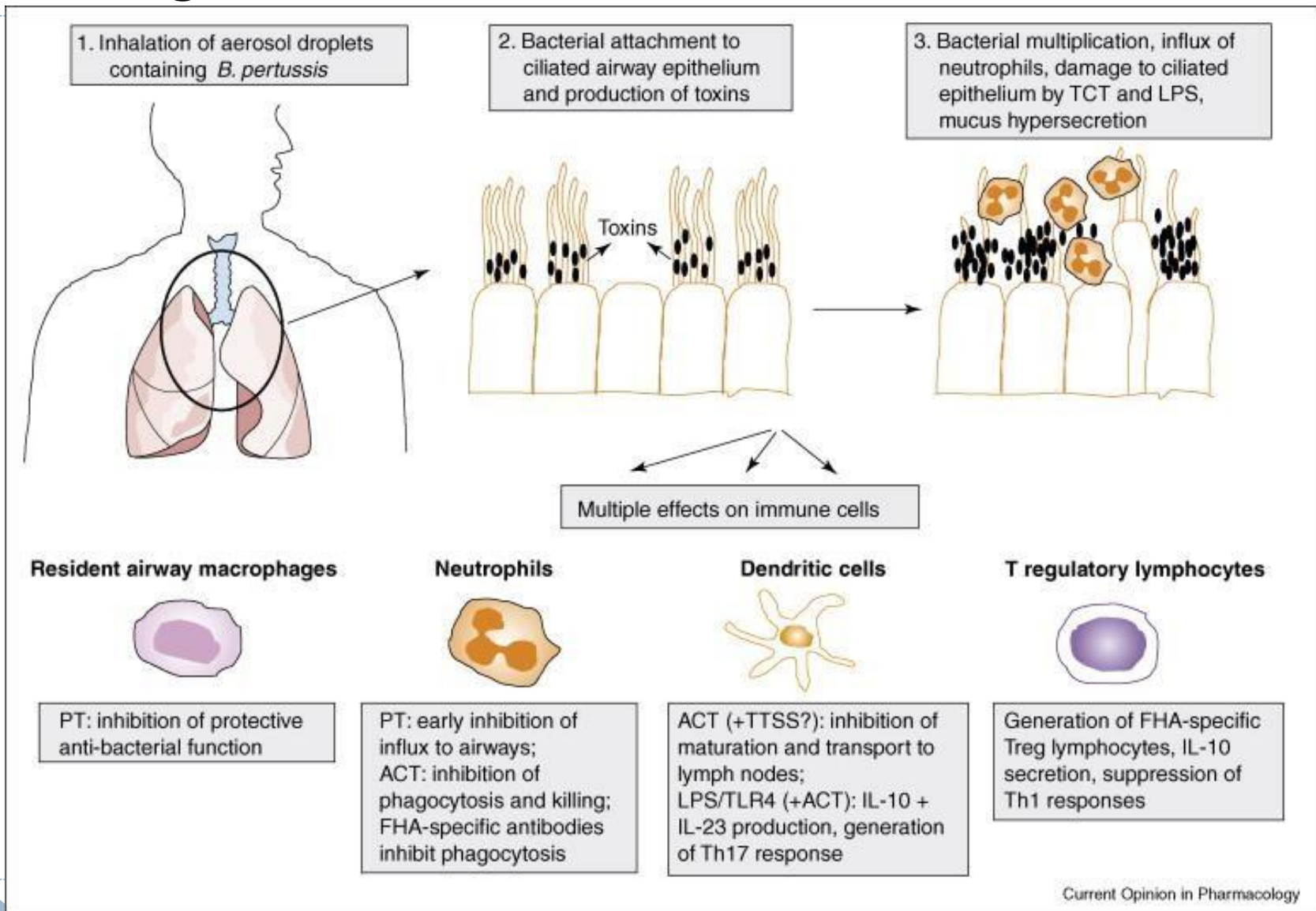
# Pathogenesis



# *Bordetella pertussis*

- ❖ Gram negative,
- ❖ aerobic,
- ❖ encapsulated *coccobacillus*
- ❖ the causative agent of pertussis or whooping cough.
- ❖ bacterium is spread by airborne droplets; its incubation period is 7–10 days on average (range 6–20 days)
- ❖ Humans are the only known reservoir for *B. pertussis*

# Pathogenesis



## *Mycobacterium Tuberculosis*

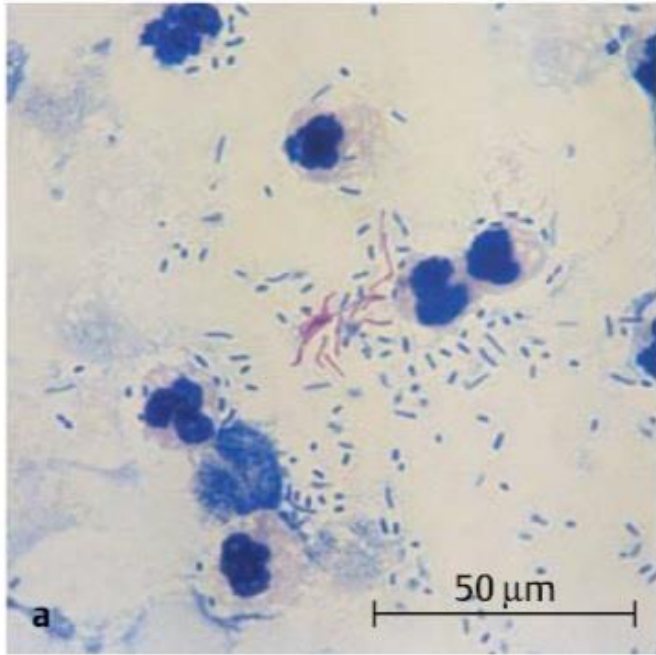
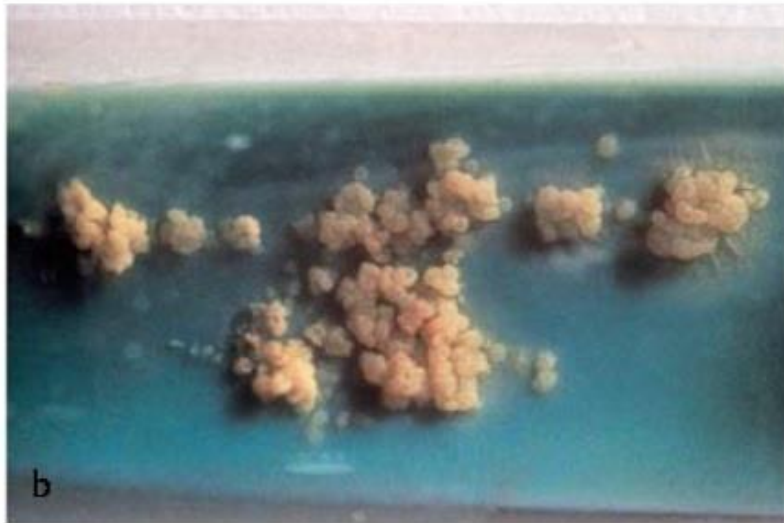


Fig.4.12 **a** Ziehl-Neelsen staining of a urine preparation: Fine, red, acid-fast rods, which tend to stick together. Clinical diagnosis: renal tuberculosis.

**b** Culture of *M. tuberculosis* on egg nutrient substrate according to Löwenstein-Jensen: after four weeks of incubation rough, yellowish, cauliflowerlike colonies.



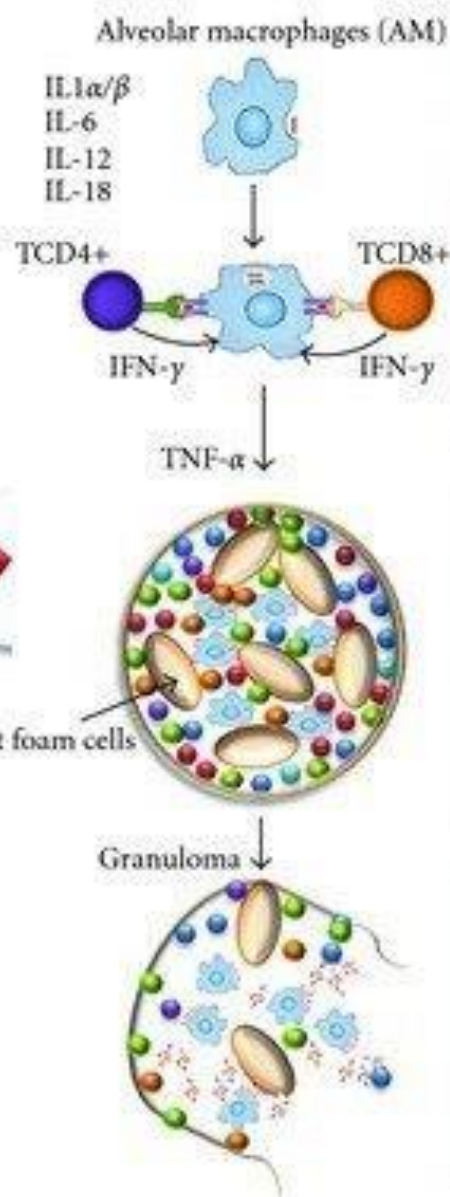
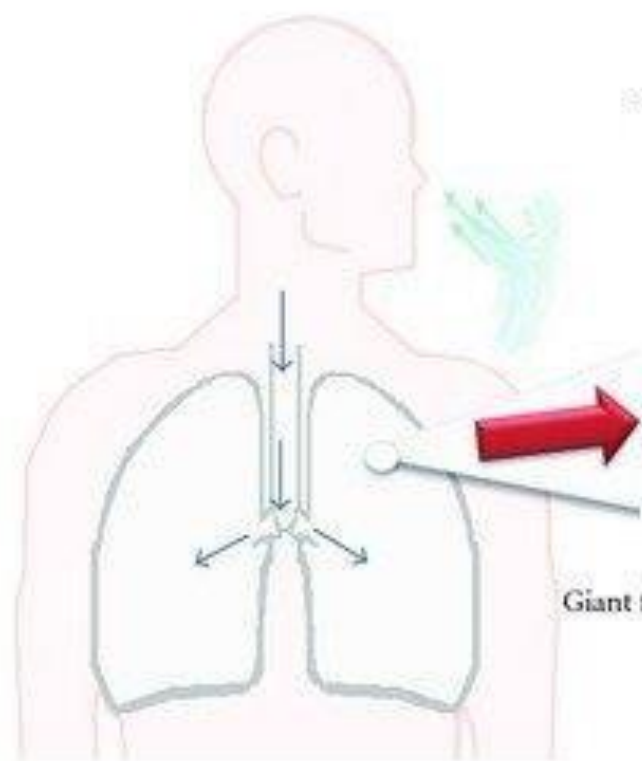
# *Mycobacterium tuberculosis*

- ❖ Over a century ago Robert Koch identified *Mycobacterium tuberculosis* as the causative agent of tuberculosis
- ❖ acid-fast rods, 0.4µm wide, and 3–4 µm long,
- ❖ Endospore forming
- ❖ non-motile.
- ❖ can be stained with special agents (Ziehl-Neelsen staining)
- ❖ *M. bovis* and *M. africanum* can also causes TB.
- ❖ obligate aerobes

# Pathogenesis

- ❖ Transmission: from other humans through droplet nuclei (1-5 micron in diameter) and the respiratory Route
- ❖ Transmission to humans from susceptible animal species and their products (e.g., milk) is also possible
- ❖ Depending on the environment, these tiny particles can remain suspended in the air for several hours.
- ❖ incubation period : about 4 to 12 weeks, and the disease develops slowly.
- ❖ symptoms : fever, fatigue, and weight loss.
  - ❖ A cough, which is characteristic of pulmonary involvement, may result in expectoration of bloody sputum.





#### Inhalation of Mtb

- Phagocytosis of bacilli

#### Inflammatory cell recruitment

- AM secreted IL-12 and IL-18
- IFN- $\gamma$  induce bacterial killing
- TNF- $\alpha$  is essential in the control of Mtb growth and granuloma formation

#### Control of mycobacteria growth

- Stops Mtb proliferation
- Chronic cytokine stimulation
- Granuloma is formed by several cells recruited to the lung. Inside, infected macrophages contain the Mtb preventing their spread.

#### Postprimary tuberculosis

- Mycobacteria persistence is associated to a failure in the immune-surveillance
- Disease may reactivate
- Damage of nearby bronchi
- Spreading of the Mtb to other areas of the lung

# Neisseriaceae

- ❖ Gram-negative cocci often arranged in pairs (diplococci) with adjacent sides flattened (like coffee beans) a diameter of approximately 1  $\mu\text{m}$
- ❖ Encapsulated
- ❖ Non sporeforming
- ❖ Aerobic
- ❖ Nonmotile
- ❖ Important human species
  - ❖ *Neisseria gonorrhoeae* → sexually transmitted pathogen (urethritis, cervicitis)
  - ❖ *Neisseria meningitides* (meningitis, meningoencephalitis, arthritis,)
- ❖ □ species normally colonize mucosal surfaces of oropharynx and nasopharynx and occasionally anogenital mucosal membranes



***Neisseria gonorrhoeae* and *Neisseria meningitidis***

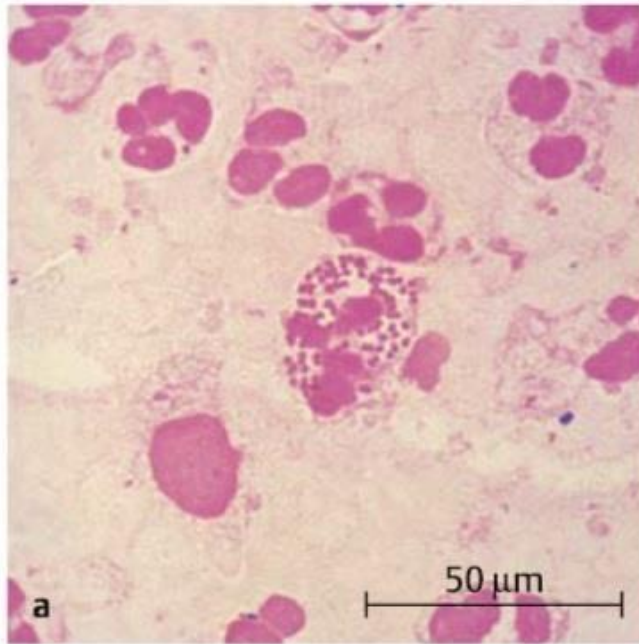
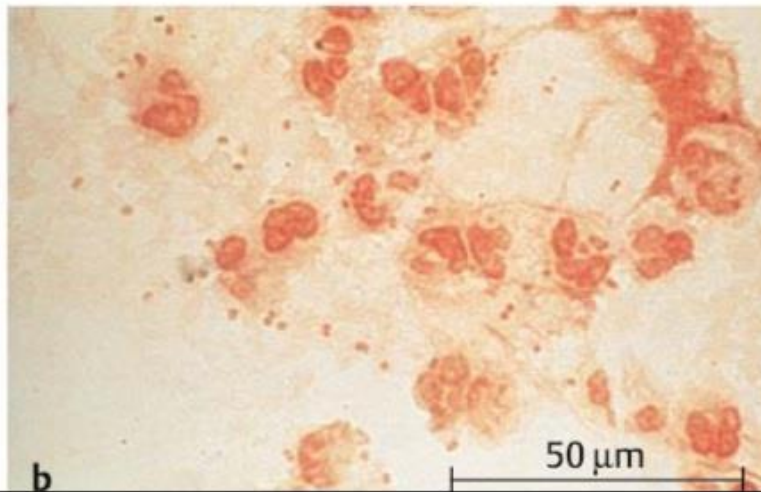


Fig. 4.16 **a** *N. gonorrhoeae*: gram staining of a preparation of urethral secretion: coffee-bean-shaped diplococci, grouped within a granulocyte. Clinical diagnosis: gonorrhoea. **b** *N. meningitidis*: gram staining of a preparation of cerebrospinal fluid sediment. Clinical diagnosis: acute purulent meningitis.



# Neisseria meningitides

- ❖ Gram negative cocci shaped
- ❖ appears in kidney bean shape under the microscope .
- ❖ It requires anaerobic environment with 5% CO<sub>2</sub> and enriched media containing blood for growth oxidase and catalase positive.
- ❖ Serogroups A, B, C, D, etc. (a total of 12

## **Epidemiology:**

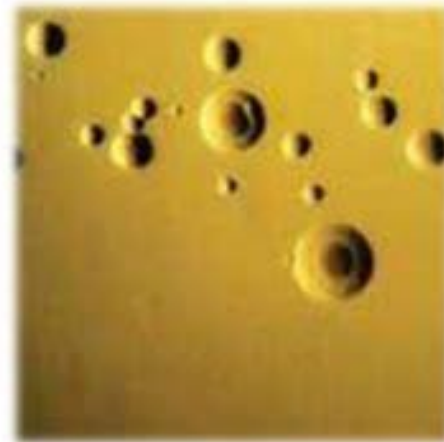
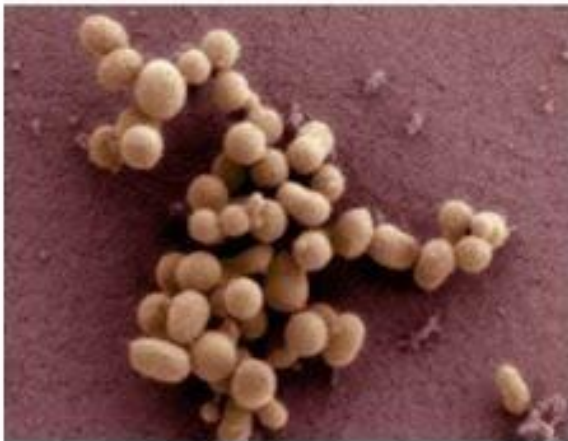
- ❖ Humans only natural hosts
- ❖ Person-to-person transmission by aerosolization of respiratory tract secretions in crowded conditions
- ❖ Close contact with infectious person
- ❖ Highest incidence in children younger than 5 years and particularly those younger than 1 year of age

# Mycoplasmataceae

- ❖ Do not possess rigid cell walls for lack of a murein layer
- ❖ Pleomorphic but most common form is coccoid cell with a diameter of 0.3–0.8  $\mu\text{m}$ .
- ❖ Long,
- ❖ fungi like filaments grown on culture mediums with high osmotic pressure levels.
- ❖ frequently causes pneumonias that run atypical courses, especially in young children.
- ❖ 10 -20% of pneumonias contracted outside of hospitals are caused by this pathogen
- ❖ Common species:
- ❖ *Mycoplasma pneumoniae*
- ❖ *Ureoplasma*
- ❖ Infections of the respiratory organs or urinary tract.

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# MYCOPLASMA



# Pathogenesis

- ❖ transmitted by aerosol droplets → cells attach themselves to the epithelia of the trachea, bronchi, and bronchioles → destruction of the epithelial cells
- ❖ → infection develops into pneumonia with an inflammatory exudate in the lumens of the bronchi and bronchioles.
- ❖ The incubation period is 10–20 days.
- ❖ Symptoms : fever, headache, and a persistent cough.

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***THANK YOU***