Epidemiology

of infectious diseases

Kolářová M., EPI Autumn 2015

EPIDEMIOLOGY

*is the **study*** (scientific, systematic, data-driven)

*of the **distribution*** (frequency, pattern)

*and **determinants*** (causes, risk factors)

*of **health-related states or events*** (not just diseases)

*in **specified populations*** (patient is community, individuals viewed collectively),

*and the **application*** (since epidemiology is a discipline within public health)*of this study to the control of health problems.*

In tracking a disease outbreak, epidemiologists may use any or all of three types of investigation:

a) **descriptive** epidemiology

is the collection of all data describing the occurrence of the disease

b) **analytical** epidemiology

attempts to determine the cause of an outbreak

c) **experimental** epidemiology

tests a hypothesis about a disease or disease treatment in a group of people.

Occurrence of Disease

- Incidence - the incidence rate refers to the number of new cases of a disease in a given population over a period of time.
- Prevalence - the prevalence rate refers to the number of total cases of a disease in a given population at a specific time.

Sporadic disease	Disease that occurs occasionally in a population.
Endemic disease	Disease constantly present in a population.
Epidemic disease	Disease acquired by many hosts in a given area in a short time.
Pandemic disease	Worldwide epidemic.

Epidemiologic investigations are largely mathematical descriptions of persons in groups, rather than individuals.

The basic quantitative measurement in epidemiology is a count of the number of persons in the group being studied who have a particular disease.

Epidemiologists arrange their data in various ways, depending on what aspect of the information they want to emphasize.

One of the most powerful tools an epidemiologist can use is case reporting: reporting specific diseases to

*** local,**
*** state and**
*** national health authorities,**

who accumulate the data

Modern infectious disease epidemiology

According to clasic definition,

epidemiology of infectious disease

in its theoretical part

studies the chain of infections (epidemic process)

1. the **presence of rezervoir (source)** of infection

2. the way of **transmission**

3. the **susceptibility** of the population or its individual member to the organism concerned

THE CAUSATIVE AGENT OF INFECTION (bacteria, viruses, fungi, prions, protozoa)

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man, animal → at the ende of incubation period
→ acute stage
→ cariers

2. the way of **transmission**

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THE INFECTION

= 1. **source of infection**

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A/ direct contact

touching, kissing or sexual intercourse (Staphylococcus spp., Gonococcus spp.,HIV …),
- vertical transmission – from mother to fetus (VHB, VHC, HIV, listeria, rubella, cytomegalovirus…)

B/ indirect contact

- inhalation of droplets containing the infectious agents (TBC, measles, influenza…)
- ingestion of food or water that is contaminated (salmonella, giardia, Norwalk virus, VHA….)
- biological transmission by insects (malaria, borellia….)

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Host factors : age, nutrition, genetics
immunity – natural (nonspecific),
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THE INFECTION

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the agent of infection (e.g., particular bacterium or virus),

Organism characteristic:

infectivity – capacity to multiply in host

pathogenicity – capacity to cause disease in host

virulence - pathogenicity in a specific host

immunogenicity – capacity to induce specific and lasting immunity in host

antigenic stability – can induce long-life immunity

resistance - in environment

Organisms vary in their capacity to survive in the free state and to withstand adverse environmental conditions, for example:

* heat, cold, dryness.

Sporo-forming organisms, such as tetanus bacilli which can survive for years in a dormant state, have a major advantage over an organisms like the gonococcus which survive for only a very short time outside the human host.

1. the presence of source of infection

is the site or sites in which a disease agent normally lives and reproduces.

May be classified as:

- human - at the ende incubation period,
  if is ill,
  reconvalescent,
  carriers – healthy,
  chronic diseases
- animals - at the ende incubation period,
  if is ill,
  carriers – healthy,
  reconvalescent, chronic

2. the metod of transmission

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Routes of transmission

- Air
- Food, Drink or Water
- Direct or indirect contact
  - * Transplacental
- Insects (Artropods)

Among the important environmental factors that affect an epidemic of infectious diseases are:

poverty, overcrowding, lack of sanitation,

and such uncontrollable factors:
as the season and climate.

3. the susceptibility of the population or its individual member to the organism concerned, and the characteristic of the organism itself.

Host factors :

a g e - the very young and the very elderly are more susceptible to infetious diseases than are older children and younger adults

n u t r i t i o n

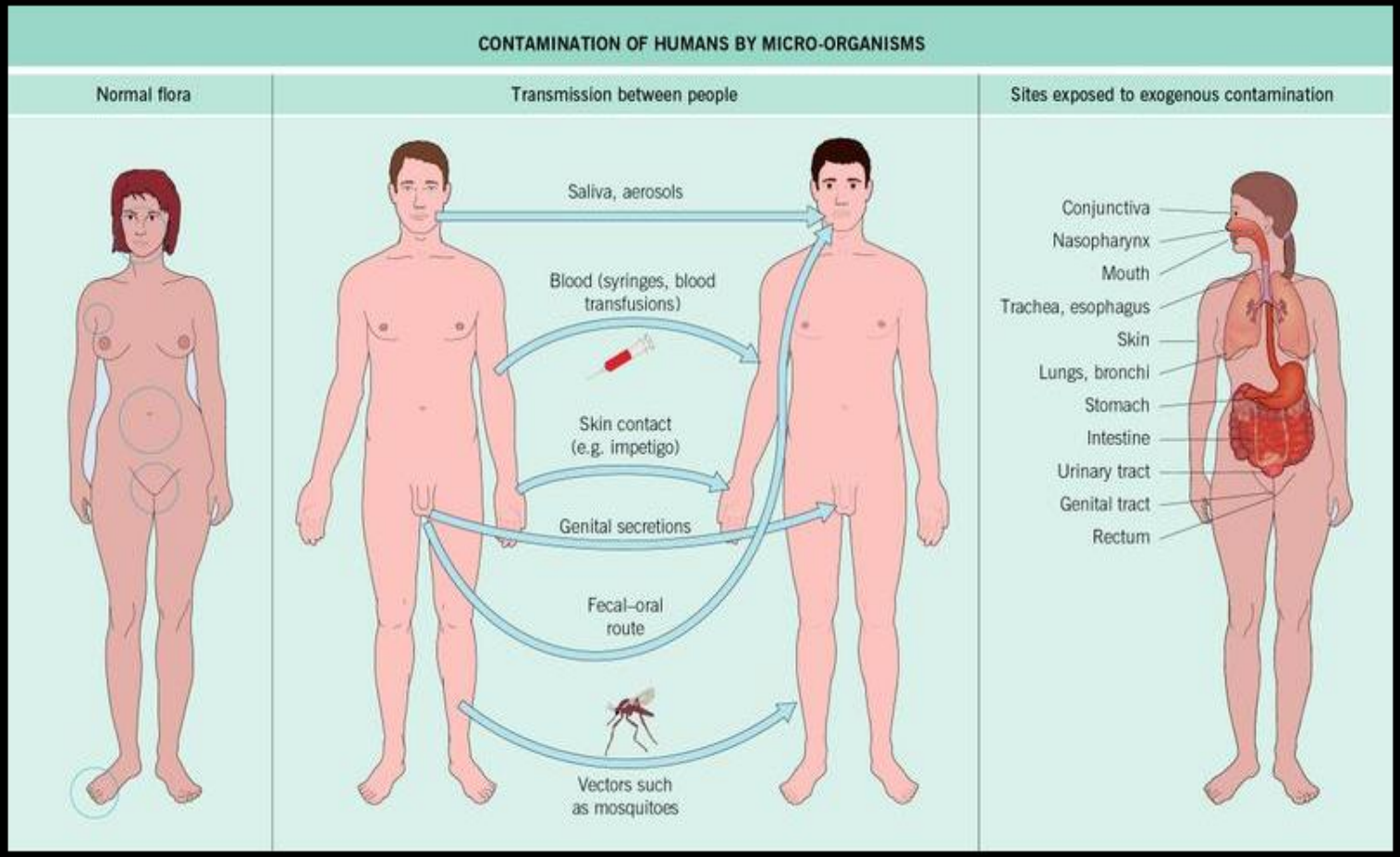
g e n e t i c s

i m m u n i t y – natural, acquired and population

Contamination of humans by micro-organisms.

Many parts of the body are colonized by normal flora, which can be the source of endogenous infection. Large numbers of micro-organisms are found in moist areas of the skin (e.g. the groin, between the toes), the upper respiratory tract, the digestive tract (e.g. the mouth, the nasopharynx), the ileum and large intestine, the anterior parts of the urethra and the vagina.

Other routes are interhuman transmission of infections and exposure to exogenous contamination.

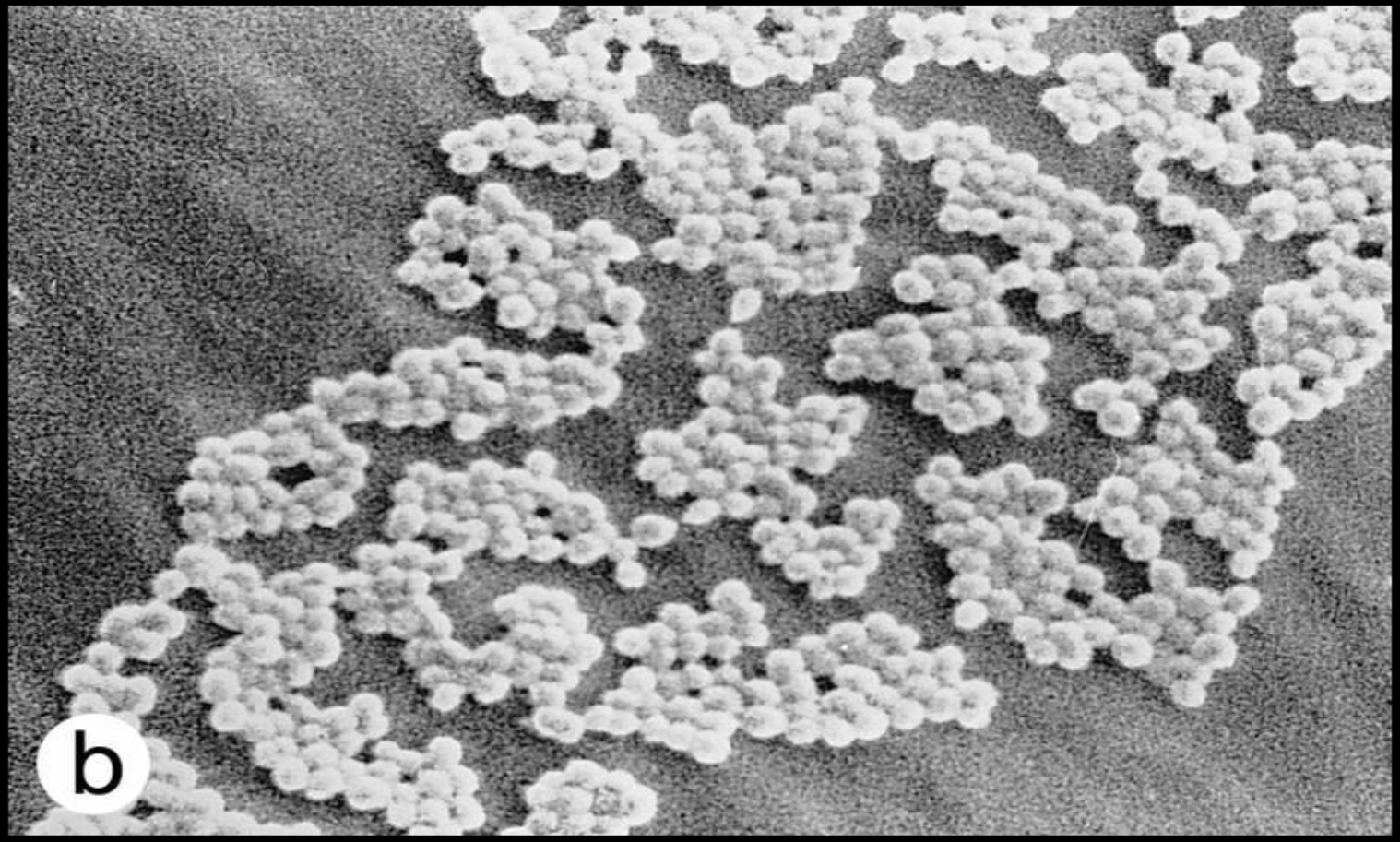

CONTAMINATION OF HUMANS BY MICRO-ORGANISMS
Normal flora
Transmission between people
Saliva, aerosols
Blood (syringes, blood transfusions)
Skin contact (e.g. impetigo)
Genital secretions
Fecal–oral route
Vectors such as mosquitoes
Sites exposed to exogenous contamination
Conjunctiva
Nasopharynx
Mouth
Trachea, esophagus
Skin
Lungs, bronchi
Stomach
Intestine
Urinary tract
Genital tract
Rectum

Main portals of entry

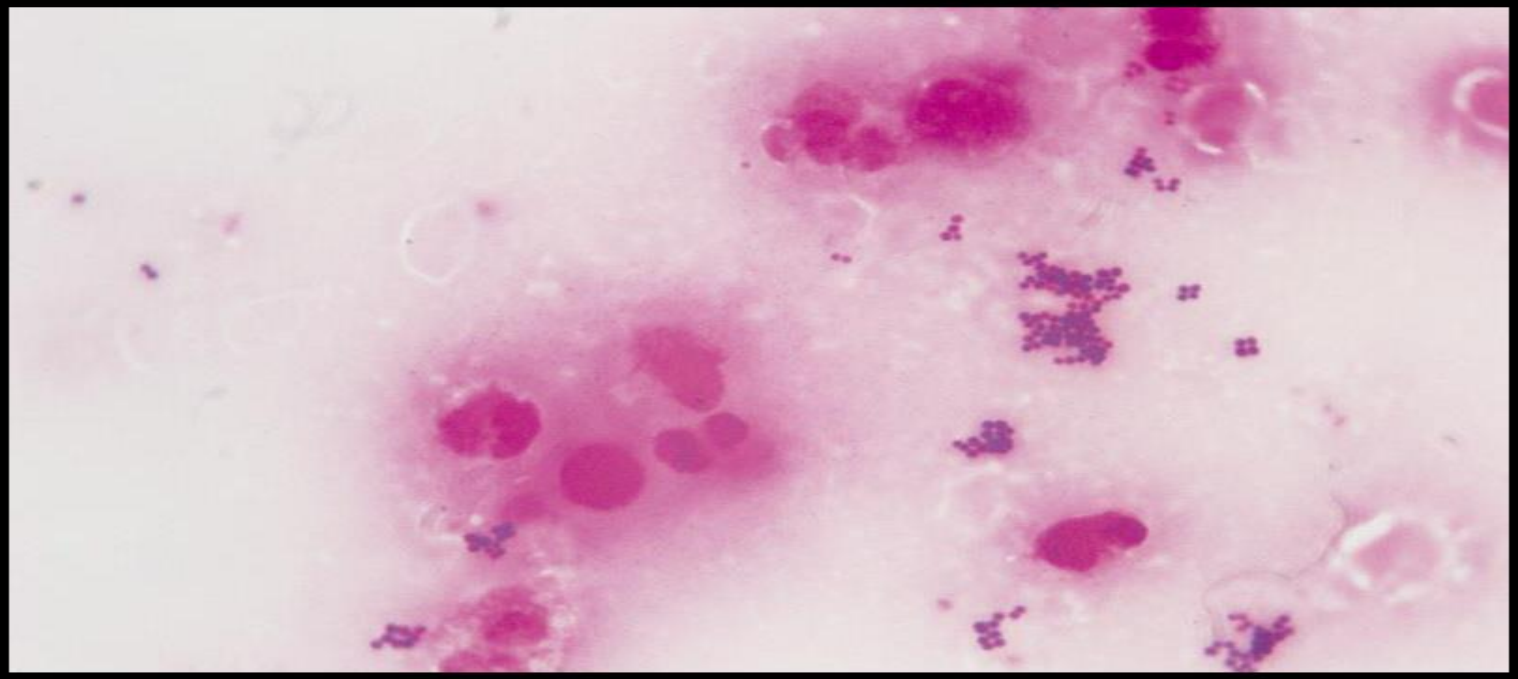
- Respiratory tract
- Gastro-intestinal tract
- Genito-urinary tract
- Direct break through skin

  * surgical and wounds
- Direct into blood via needles/catheters

Slime-producing coagulase-negative staphylococci. Scanning electron micrograph of the surface of an intravascular catheter incubated *in vitro* with (a) slime-producing and (b) nonslime-producing strains of *Staphylococcus epidermidis*. With permission from Christensen.[9]



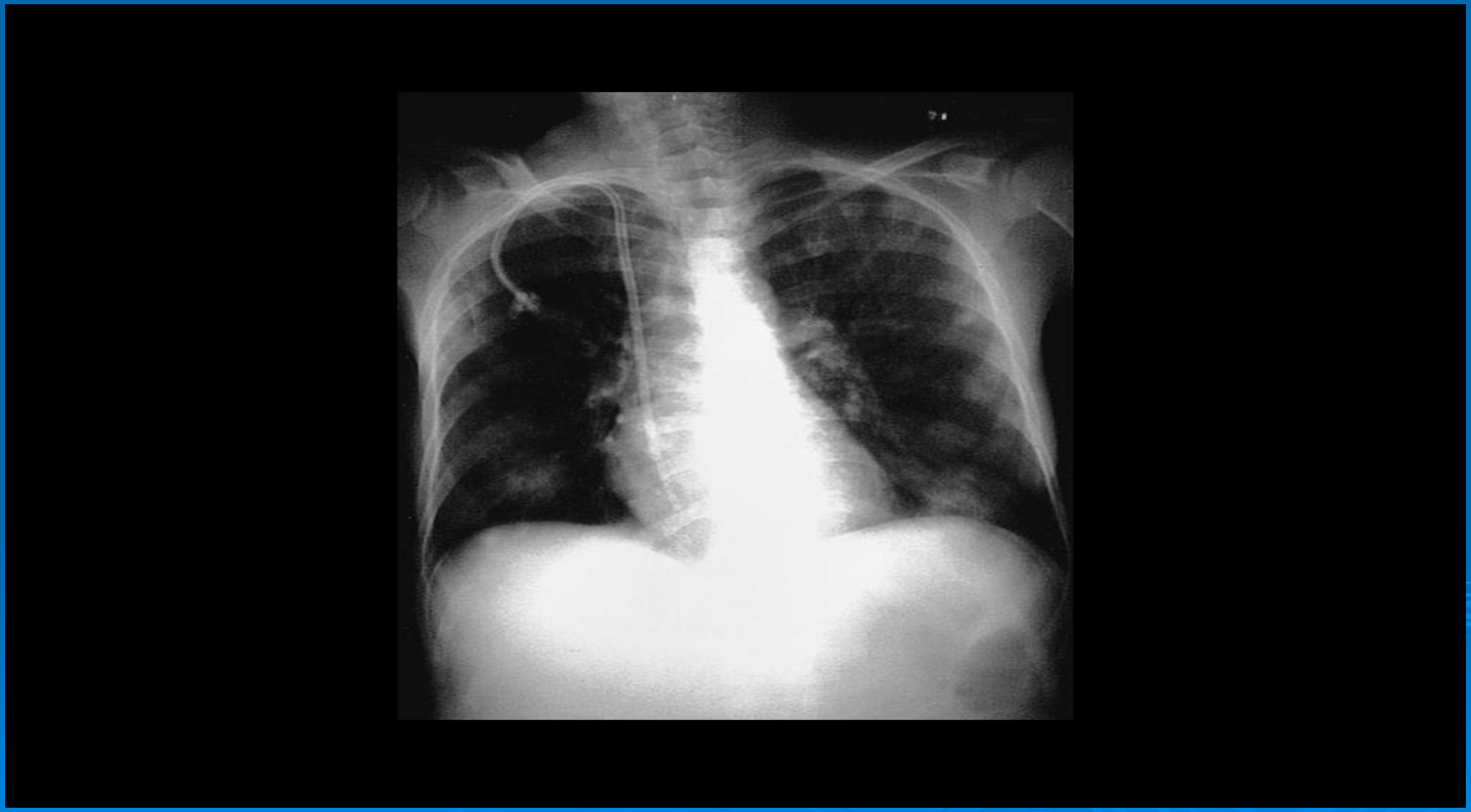
Staphylococcus aureus



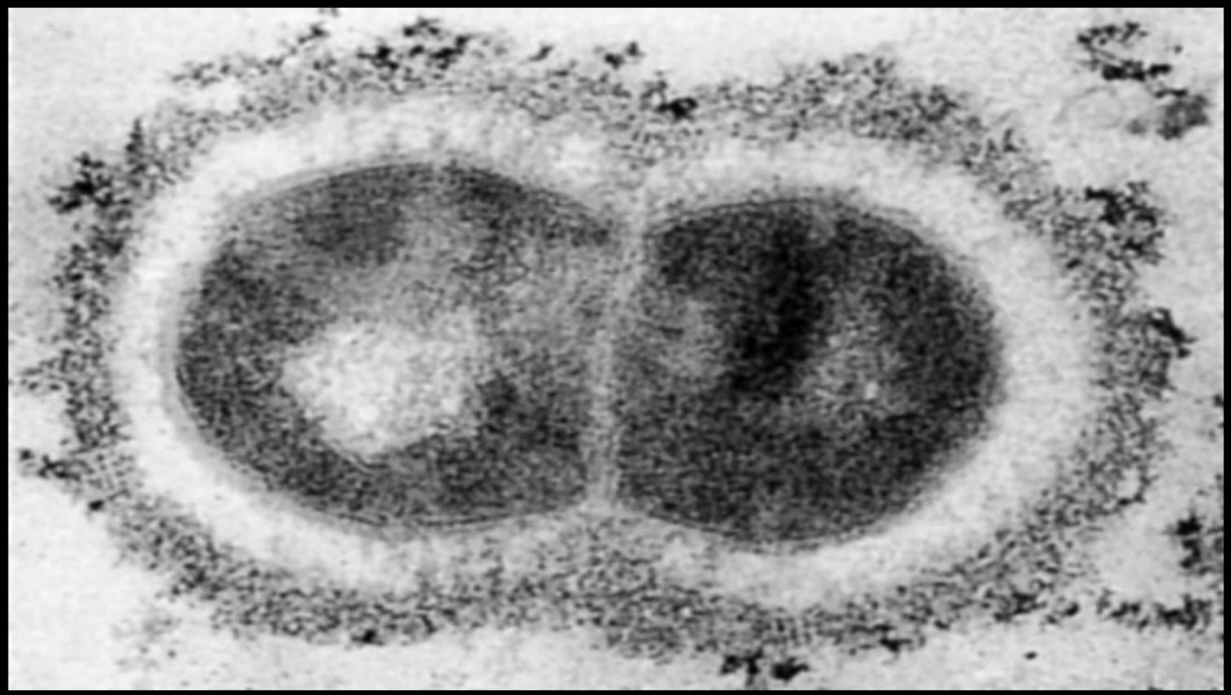
Staphylococcal nasal carriage. This patient had a small staphylococcal abscess beneath the mucosa of the nose, illustrating how *Staphylococcus aureus*, which colonizes the nares, can infect skin and submucosa. Intact mucosa is highly resistant to infection; such infections usually occur as a result of defects in the mucosal membranes or via hair follicles inside the nose.

- Impetigo in a child.

Septic pulmonary emboli. Multiple nodular pulmonary infiltrates secondary to a dialysis catheter-associated infection. The patient presented with high fevers, cough and pleuritic chest pain. *Staphylococcus aureus* was isolated from multiple blood specimens.



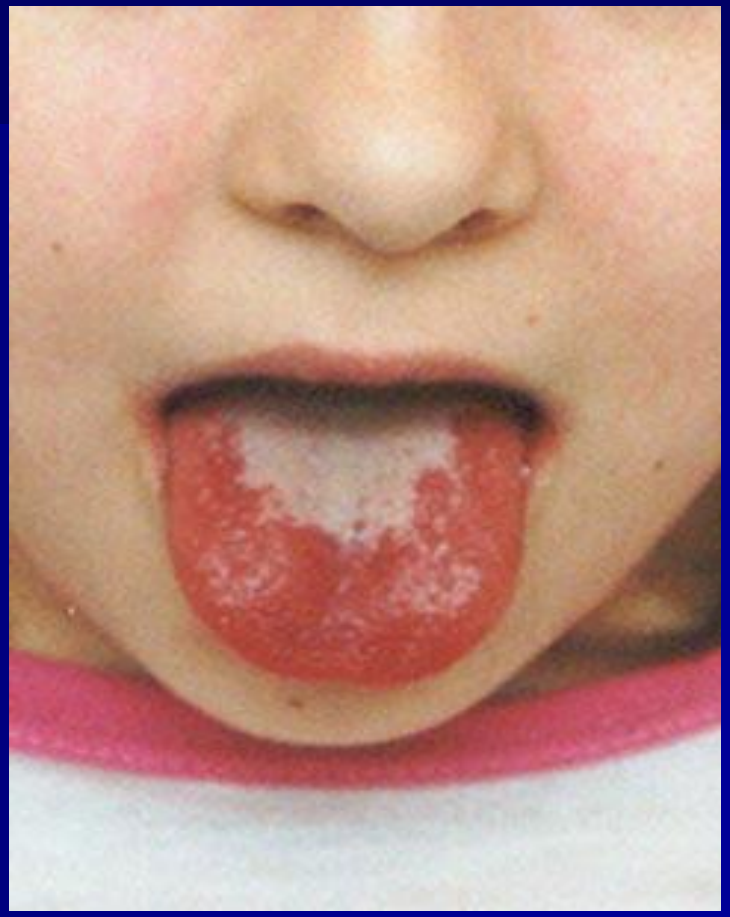
- β-Hemolytic streptococci group A on a blood agar plate. Note the clear b-hemolytic zone.



- Electron microscopy of group A streptococcus. The fuzzy M protein layer can be seen protruding from the cell wall..

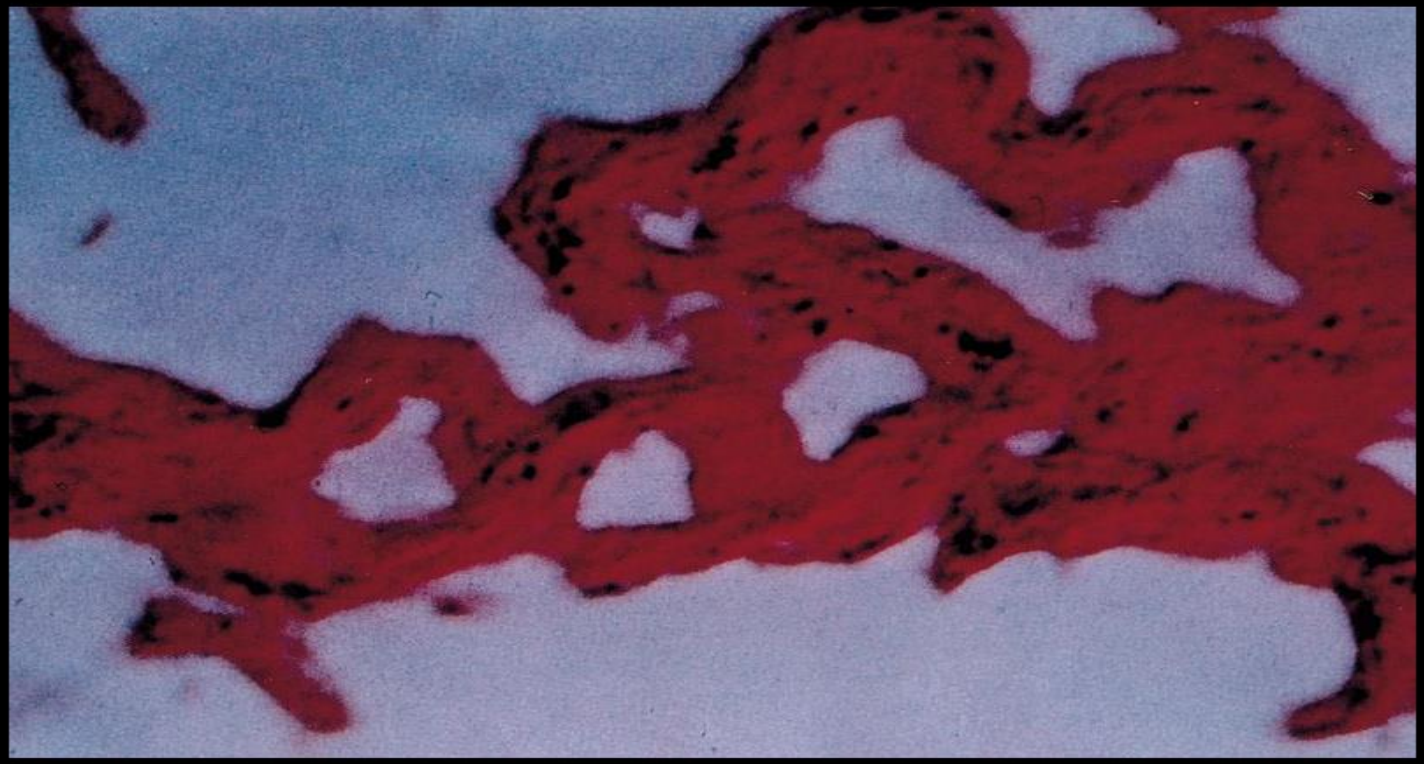
Erysipelas. Note the sharp demarcation of the affected skin.

Scarlatina (scarlet fever)



- Necrotizing fasciitis caused by **group A strepococci**. There is only moderate erythema but at surgery there was extensive soft tissue damage.

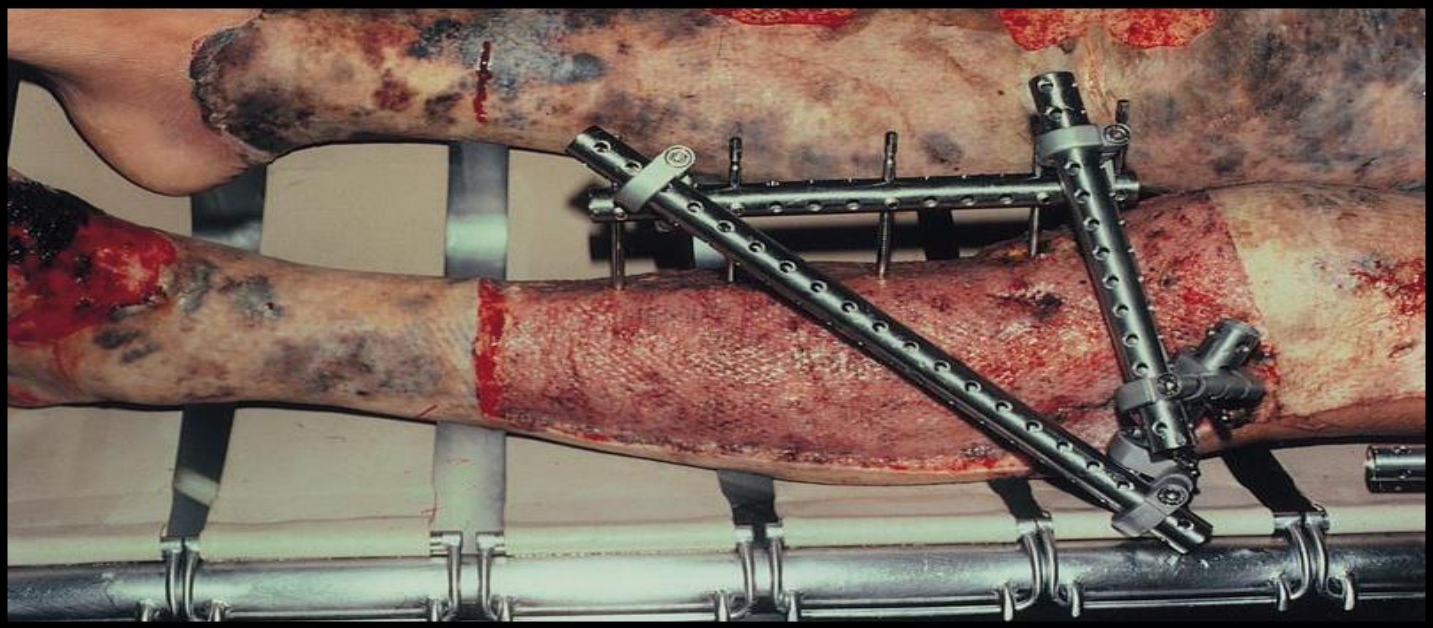
Ziehl-Neelsen stain of 'cords' of ***Mycobacterium tuberculosis*** isolated from a broth culture. Tubercle bacilli aggregate end to end and side to side to form serpentine cords, especially in broth cultures.



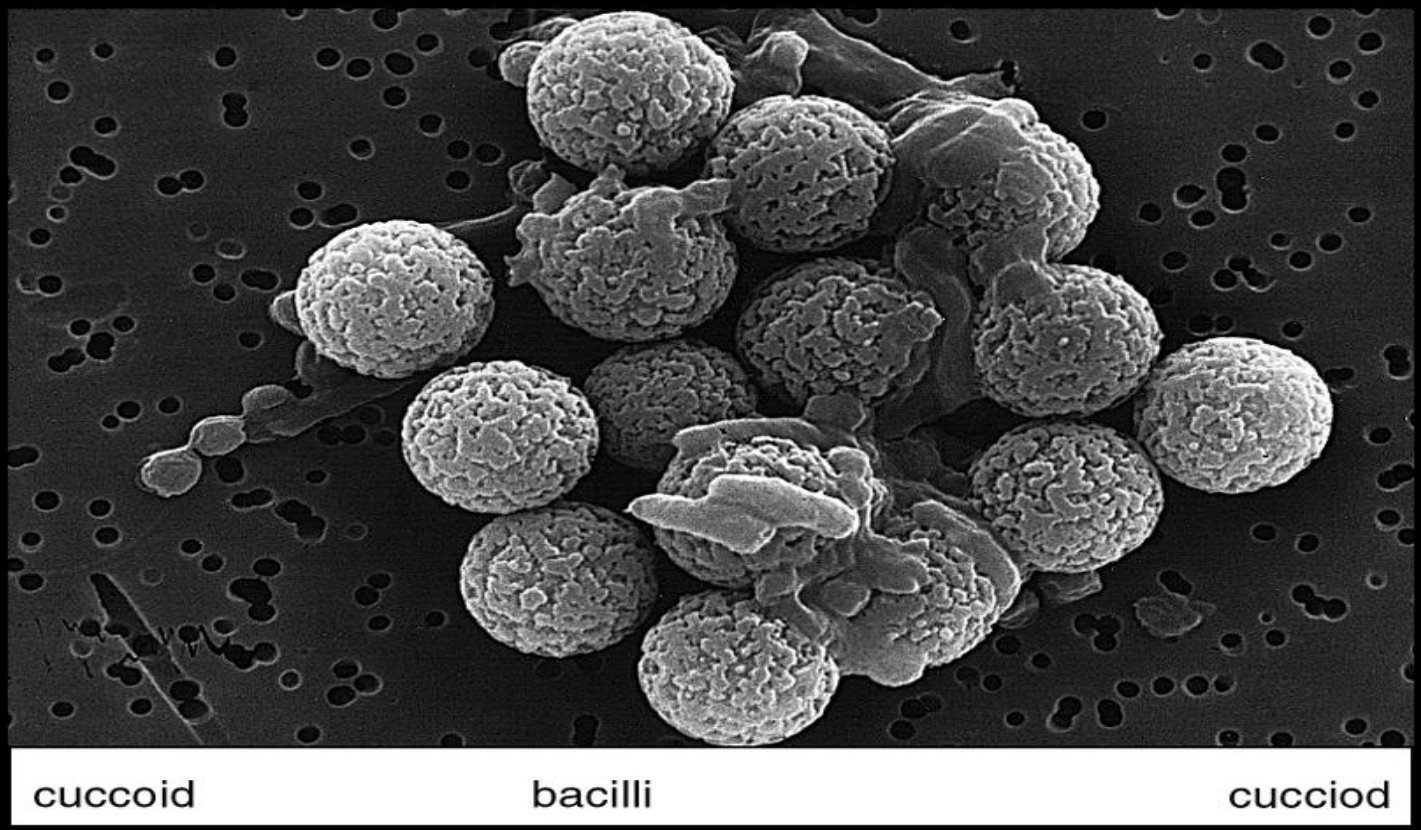
Mixed culture of two morphotypes of Enterobacteriaceae on blood agar plate (*Escherichia coli* and *Salmonella* spp.).

Pseudomonas aeruginosa **monotrichous polar flagellum seen on electron microscopy.**

Burned leg that has been superinfected with *Pseudomonas aeruginosa*.



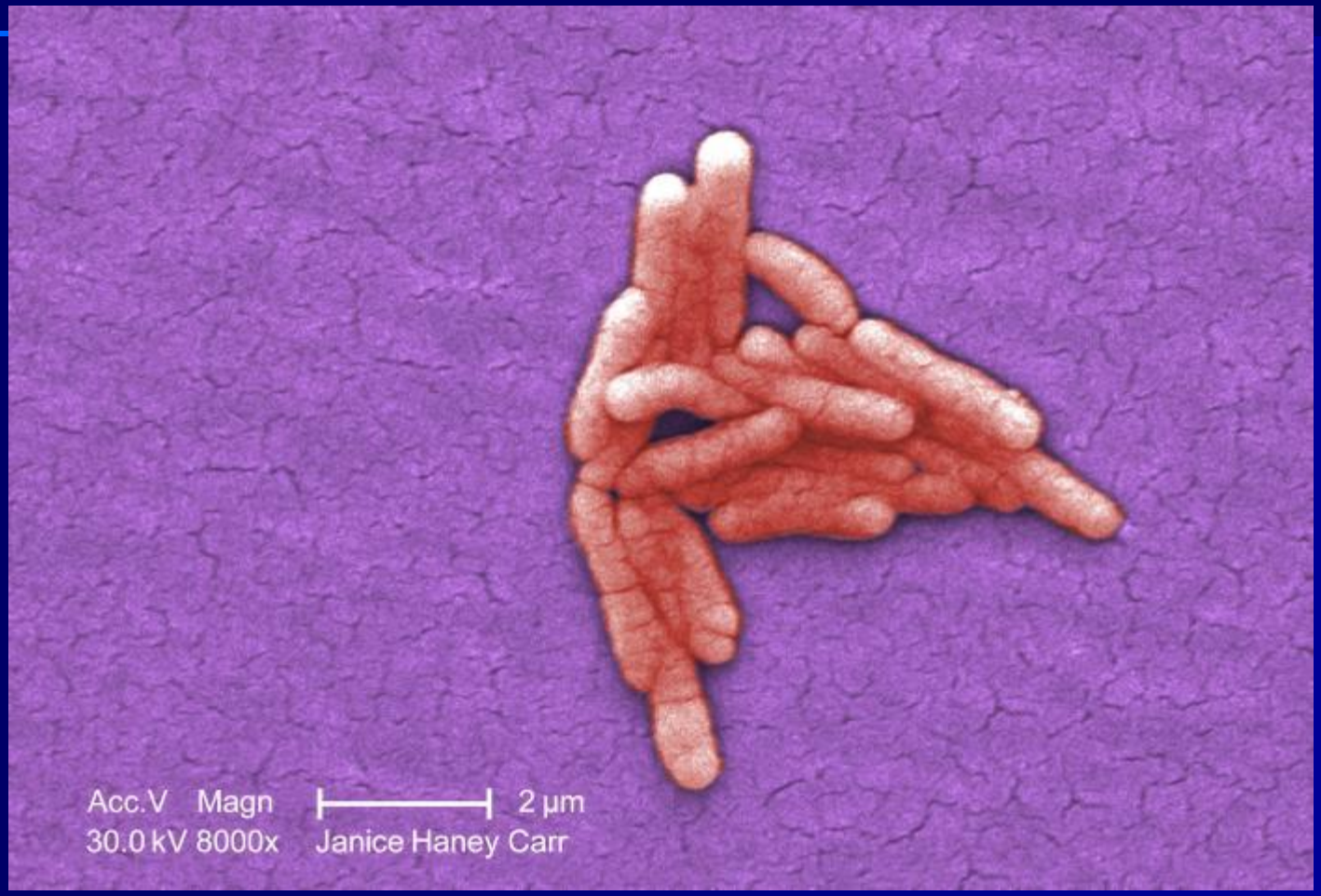
Cultured *Helicobacter pylori* in coccoid and bacilli forms, bound to immunomagnetic beads.



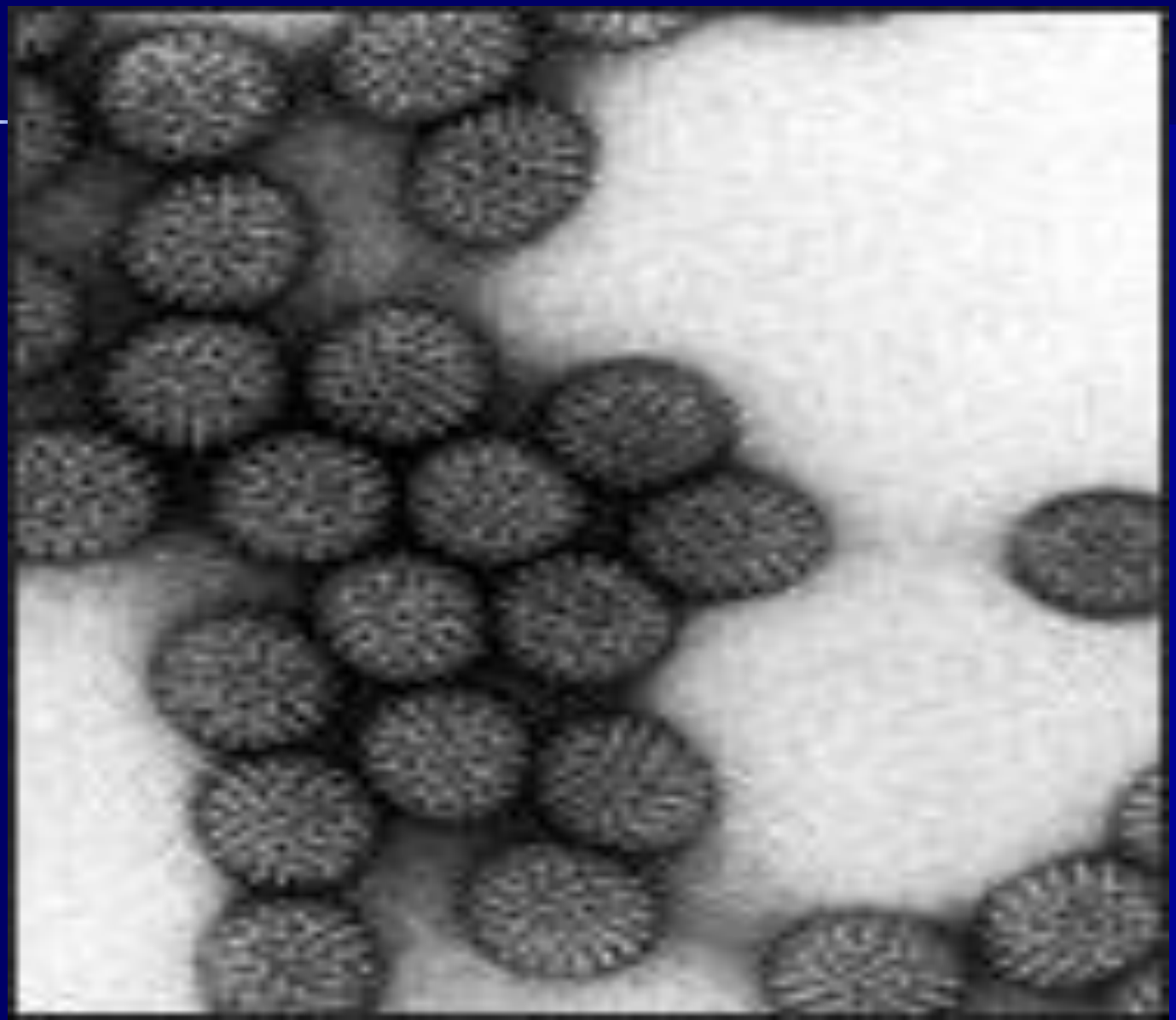
Obtained after an outbreak, this micrograph depicts Gram-positive *Clostridium difficile* bacteria.

Source: CDC

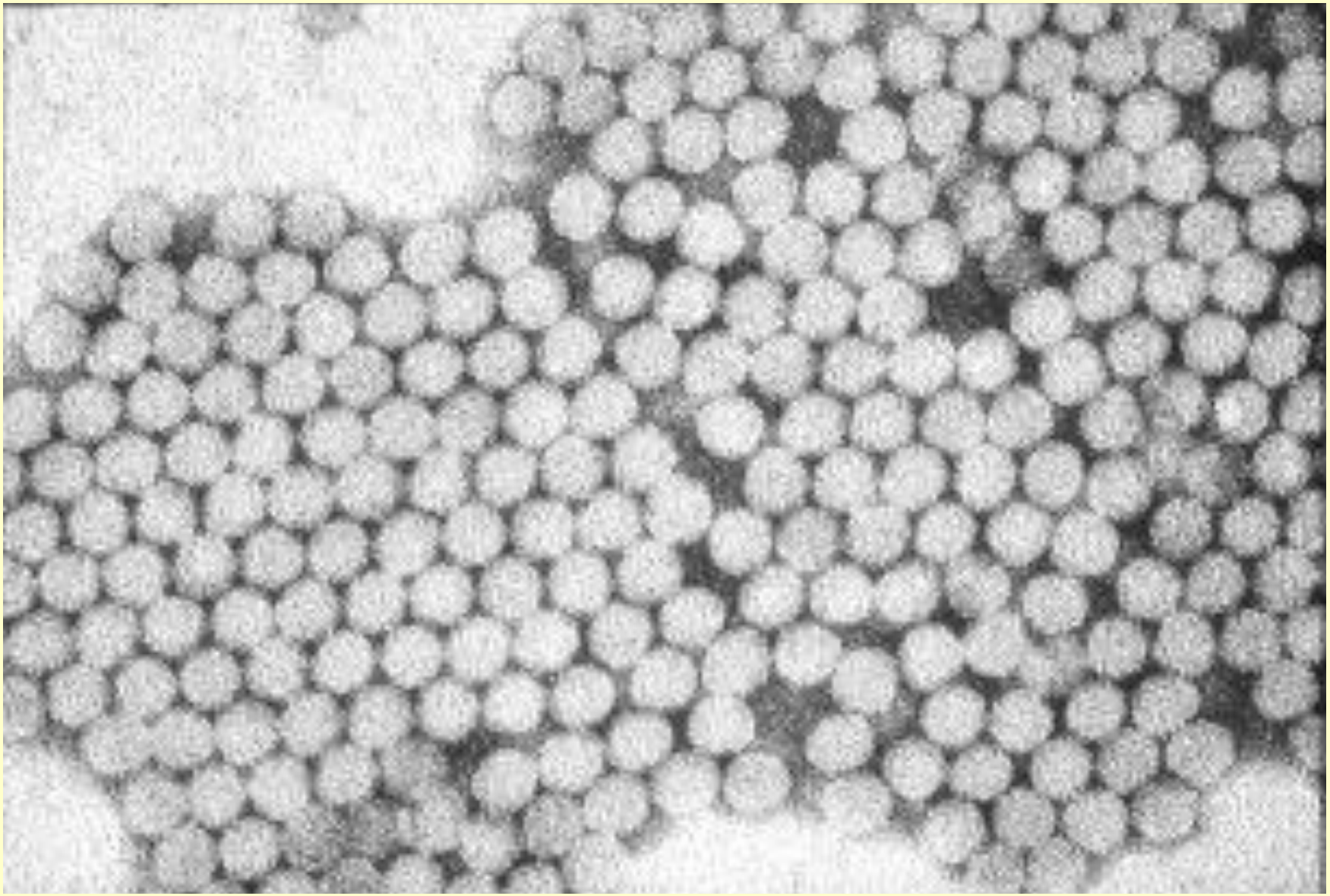
Under a moderately-high magnification of 8000X, this colorized scanning electron micrograph (SEM) revealed the presence of a small grouping of Gram-negative ***Salmonella typhimurium*** bacteria that had been isolated from a pure culture. See PHIL 10986 for a black and white version of this image.



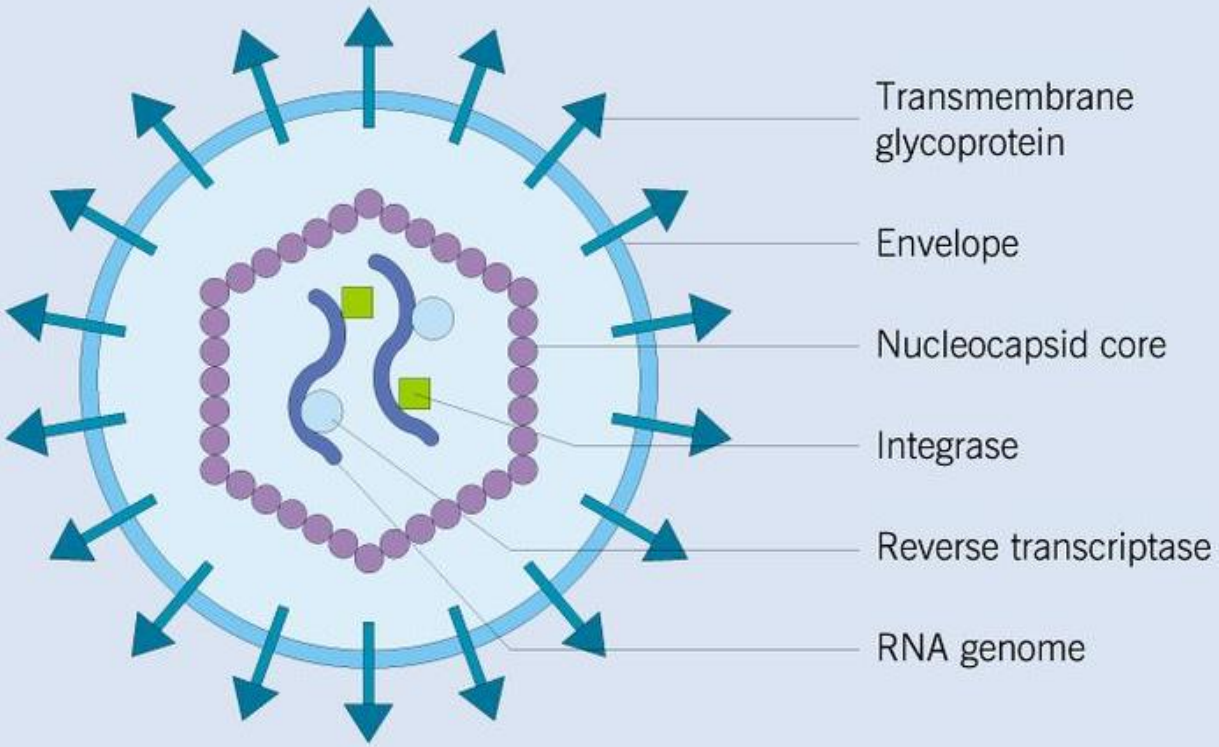
Rotavirus



HEPATITIS A VIRUS

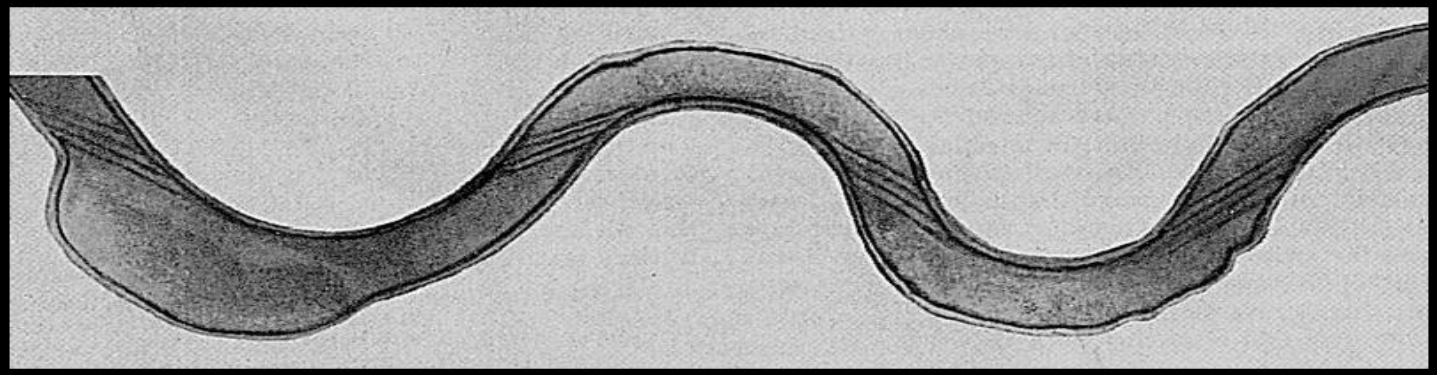


STRUCTURE OF A RETROVIRUS



Primoinfection HIV

Helical structure of *Treponema pallidum* with the periplasmic flagella.



Secondary syphilis with typical skin rash.

Gonococcal urethritis.

Colonies of *Nocardia asteroides* showing smooth chalky-white appearance.

Primary cutaneous **nocardial infection** is characteristically painless, localized and slowly progressive. (a) There is marked swelling and erythema in this child's finger. (b) However, because the finger was painless the child was not brought to medical attention until the infection had progressed to involve the entire finger.

Typical rash of meningococcal septicemia. Fine erythematous macules and petechiae are present in some areas.

Varicella (chickenpox)

Varicella (chickenpox). Lesions at various stages, including vesicles, can be seen.

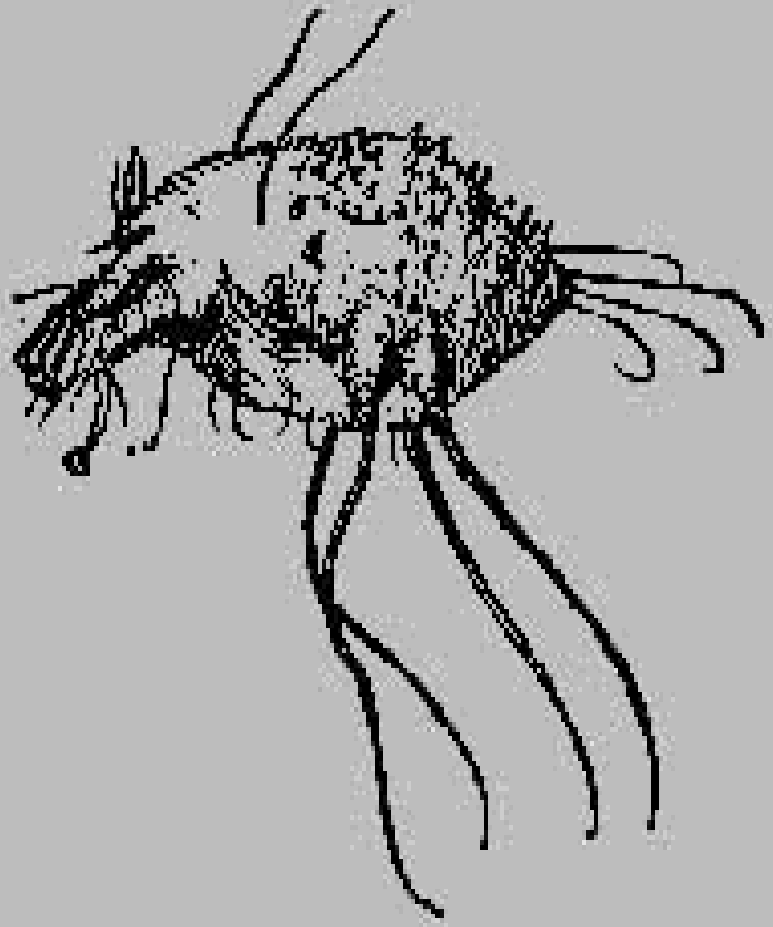
Morbilli (Measles). A disseminated erythematous rash can be seen over the trunk and arms.

Rubella. A pink macular rash can be seen on the forearm.

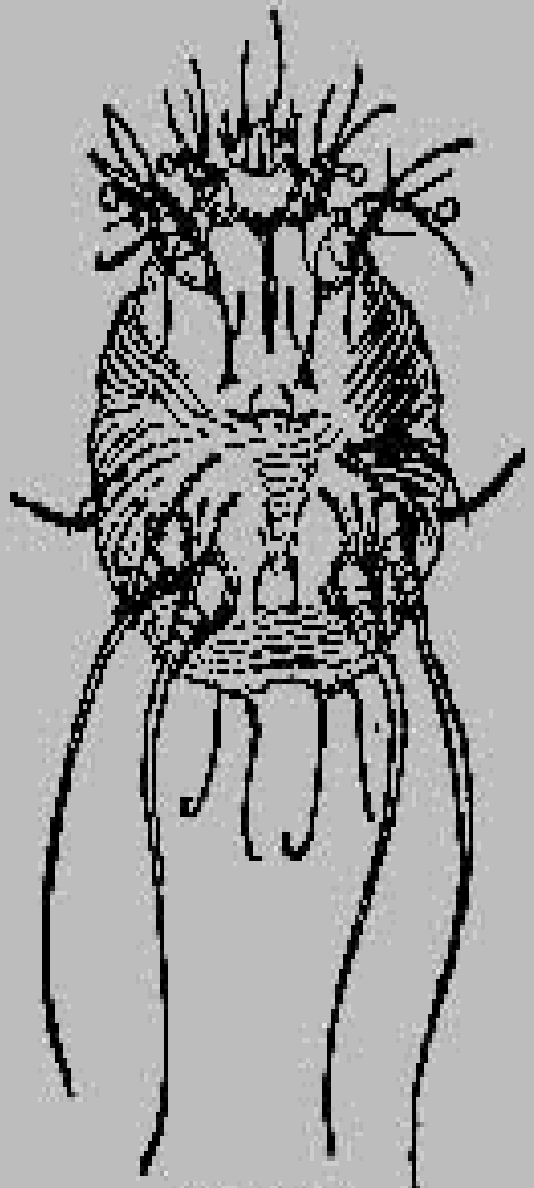
Rubella

Parotitis epidemica (mumps)

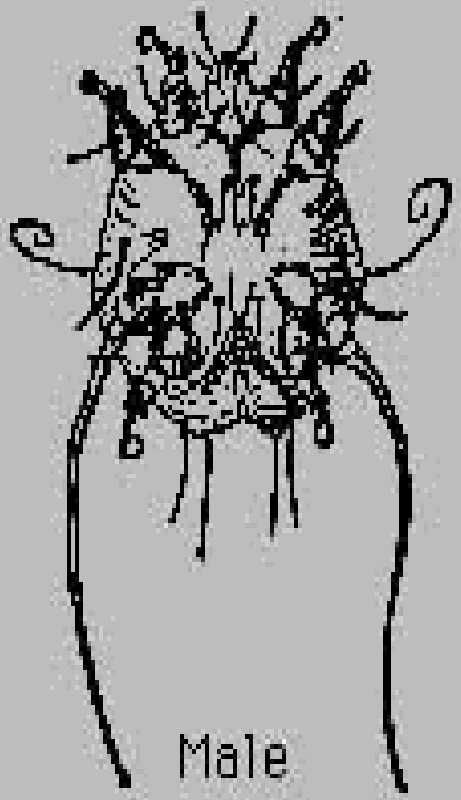
Sarcoptes scabiei



lateral



Female



Male

0.4 mm in length

Scabies

Crusted or Norwegian scabies in a patient who has AIDS.

Giemsa stain of blood with *Borellia burgdorferi*.

Tick - Ixodes ricinus

Lyme boreliosis (LB)

LB - Typical erythema migrans rash.

A blood-engorged female *Aedes albopictus* mosquito feeding on a human host.

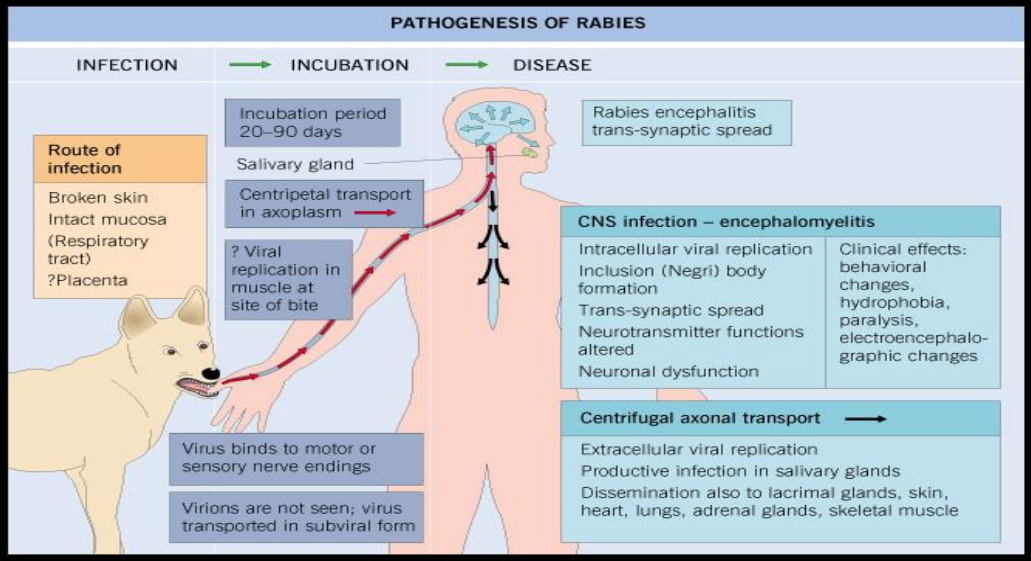
Francisella tularensis

Tularemia

Tularemia

Hlístice Trichinella spiralis

Pathogenesis of rabies.



- **The distribution of the smallpox rash is usually similar to that shown here. It is most dense on the face, arms and hands, legs and feet. The trunk has fewer pocks than the extremities.**

Smallpox is a disfiguring disease. Three out of ten cases may die. It is caused by variola virus. The disease is spread by secretions from the patient's mouth and nose, and by material from pocks or scabs. It is transmitted directly from one person to the next. Close contact with patients, or their clothing or bedding, is thus required for infection. A patient who has developed the distinctive symptoms of smallpox will have been exposed to the virus about two weeks previously.

If the epidemiology is know, we can interfere with transmission:

„BREAKING THE CHAIN OF INFECTION“

Different infections have different epidemiologies and thus require different methods of control

In the practical part it is preoccupied with

preventive measures
repressive measures
related to infectious diseases

The 14 steps of an epidemic investigation

1. Confirm the existence of an epidemic.
2. Verify the diagnosis.
3. Develop a case definition.
4. Develop a case report form.
5. Count the cases (i.e., an approximate analysis).
6. Orient the data (i.e., time, place, and person).
7. Analyze the data (e.g., agent, transmission, and host).
8. Develop a hypothesis.
9. Test the hypothesis.
10. Plan and implement control and prevention measures.
11. Evaluate the implemented measures.
12. Establish or improve the public health surveillance.
13. Write a report.
14. Plan and conduct additional studies.