Epidemiology

of infectious diseases

Kolářová M., EPI Autumn 2019

Epidemiology

is the study of the:
occurrence,
frequency,
distribution and
causes of diseases
in a given population.

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

a) **descriptive** epidemiology
b) **analytical** epidemiology,
c) **experimental** epidemiology.

a) descriptive epidemiology

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

2. **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.

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.

Any description of a group suffering from a particular disease must be put into the context of the larger population.

This shows what proportion of the population has the disease:

the prevalence rate refers to the total number of cases of a disease in a given population at a specific time.

the incidence rate refers to the number of new cases of a disease in a population over a period of time.

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)

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

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

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

2. the way of **transmission** 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….)

3. the **susceptibility** of the population or its individual members to the organism concerned Host factors : age, nutrition, genetics
immunity – natural (nonspecific),
- acquired

THE INFECTION

= 1. **source of infection**

.....

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

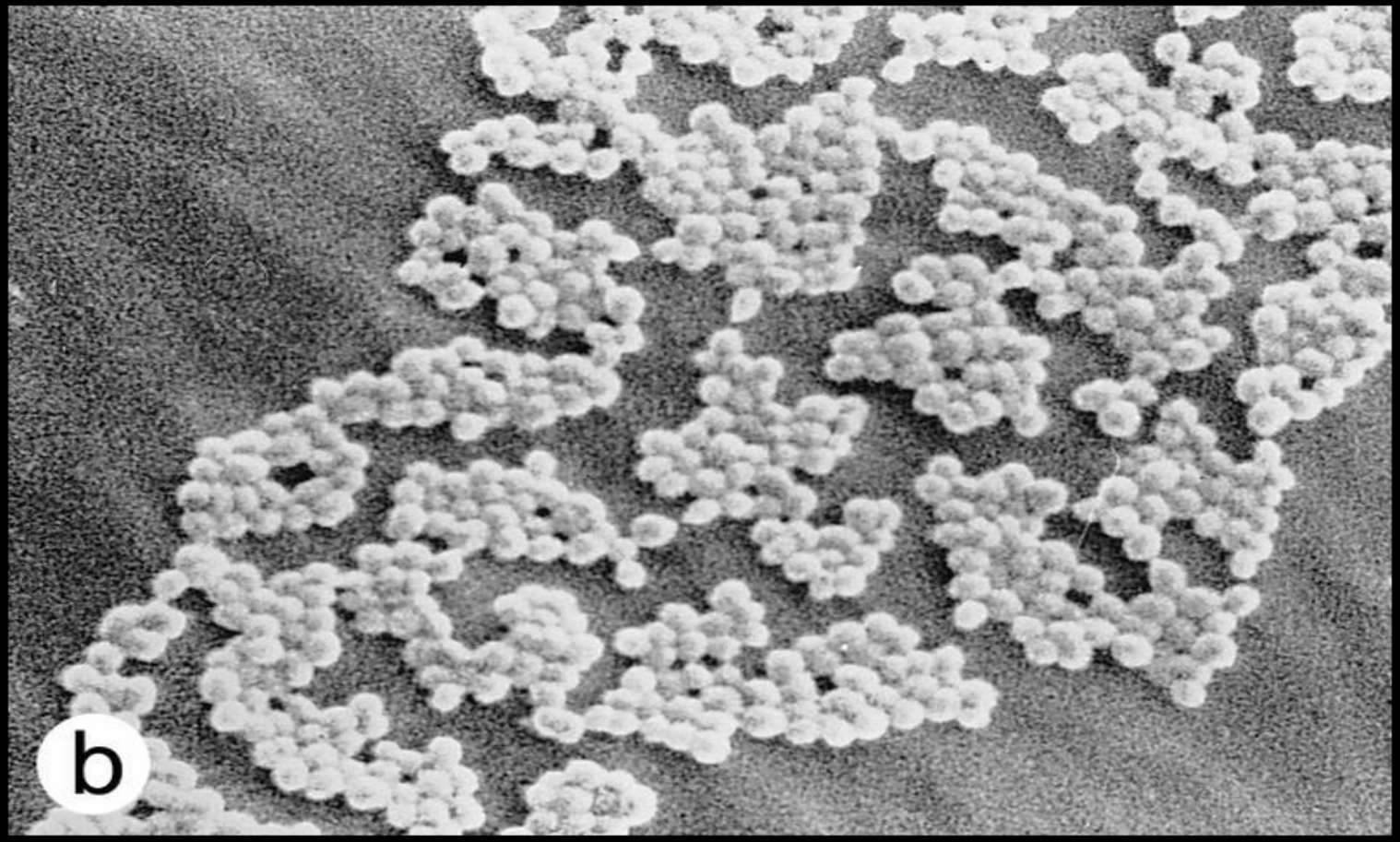
resistance - in environment

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

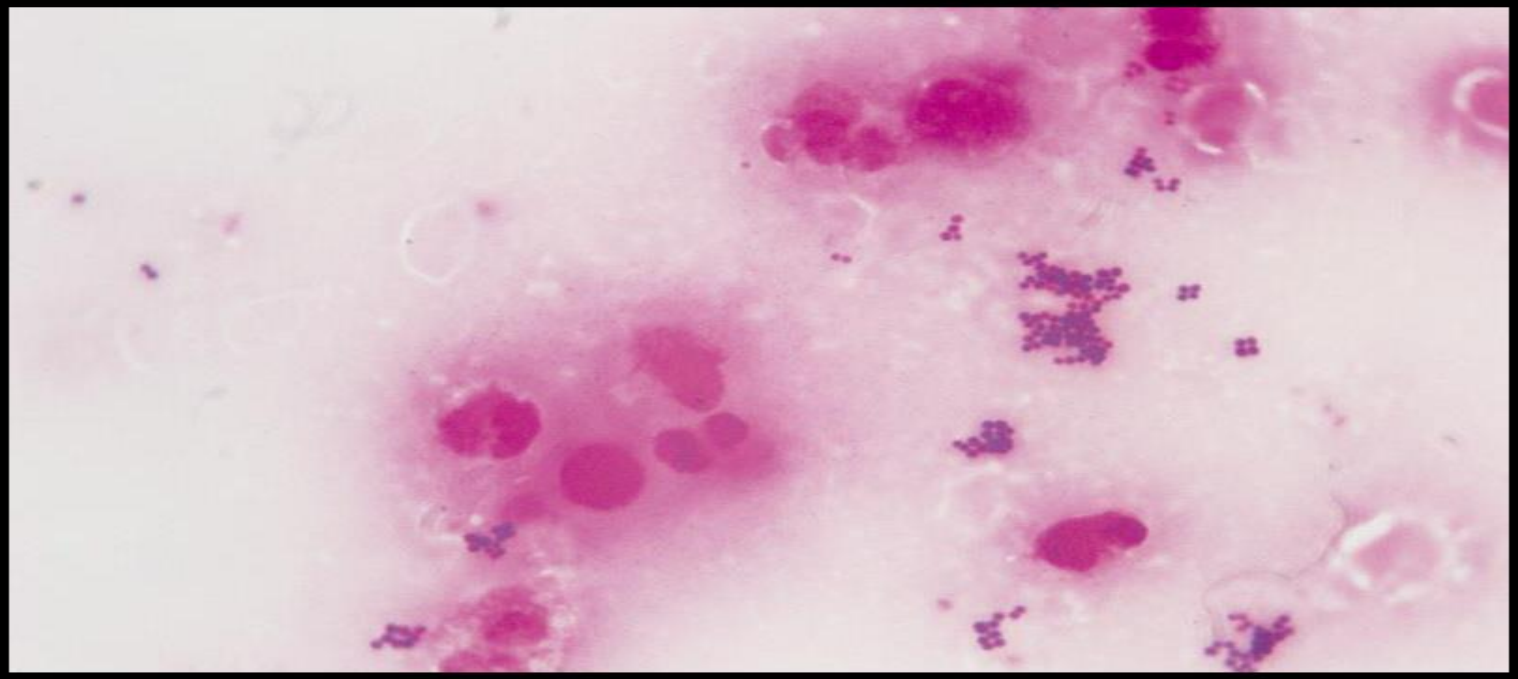
* heat, cold, dryness.

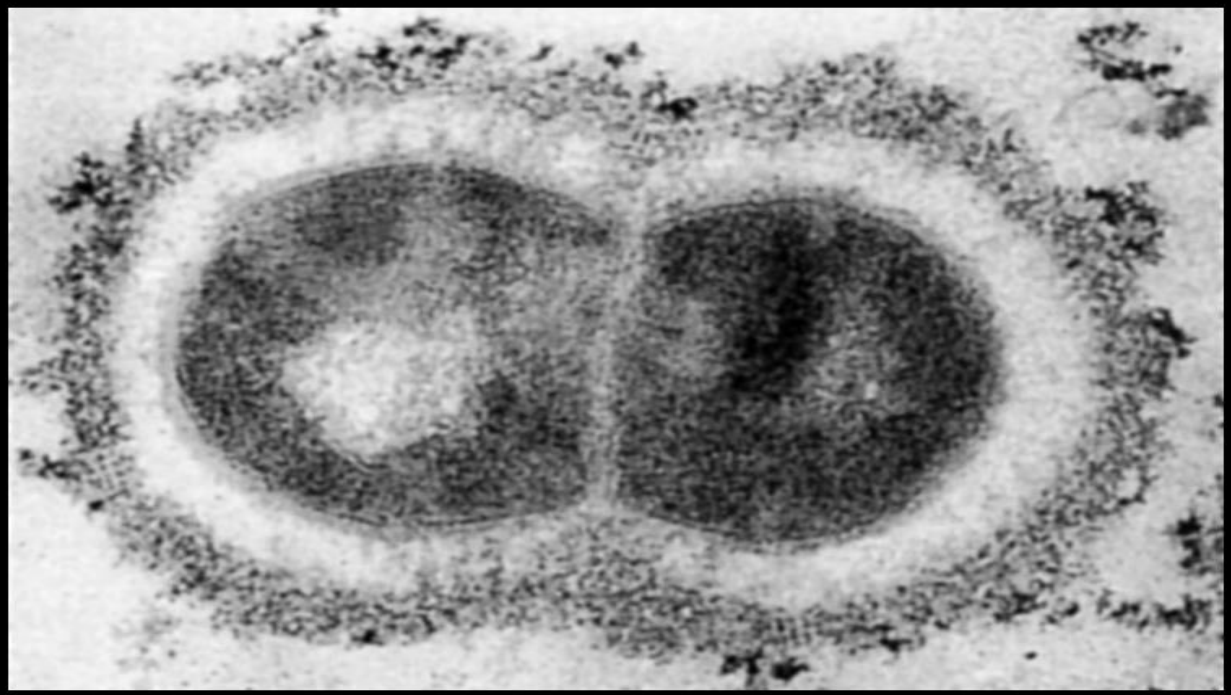
Sporo-forming organisms, such as tetanus bacilli which can survive for years in a dormant state, have a major advantage over an organisms like the gonococcus which survive for only a very short time outside the human host.

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



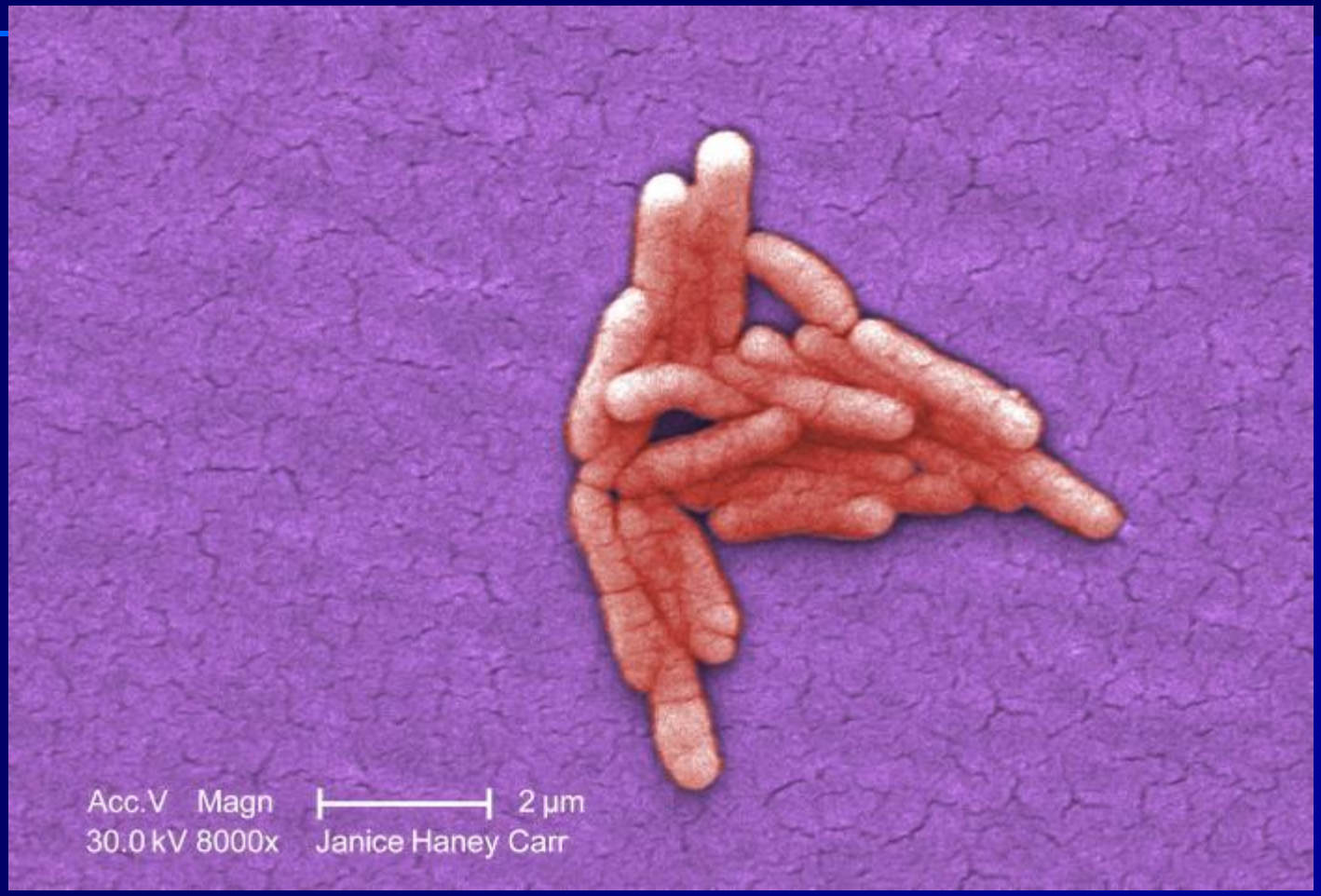


- Electron microscopy of group A streptococcus. The fuzzy M protein layer can be seen protruding from the cell wall..

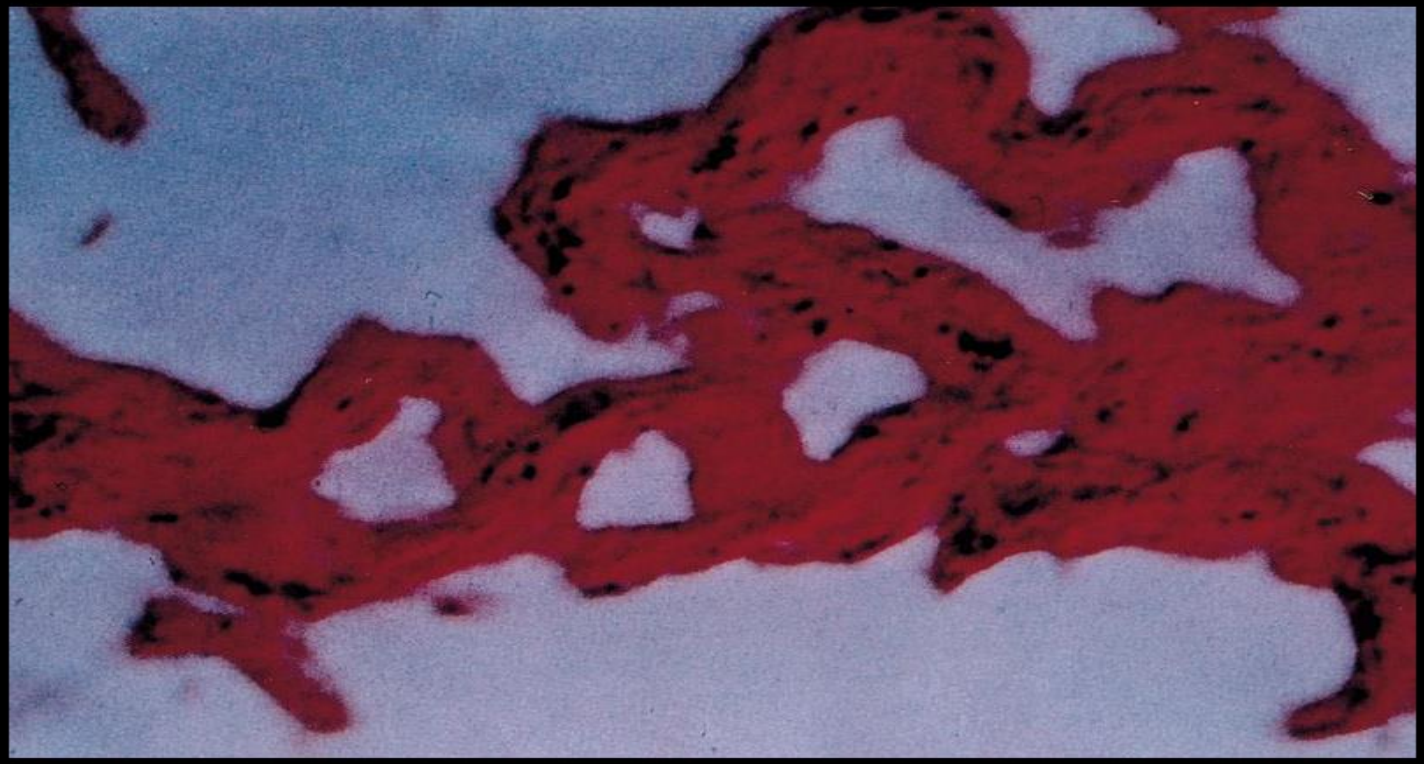
Obtained after an outbreak, this micrograph depicts Gram-positive *Clostridium difficile* bacteria.

Source: CDC

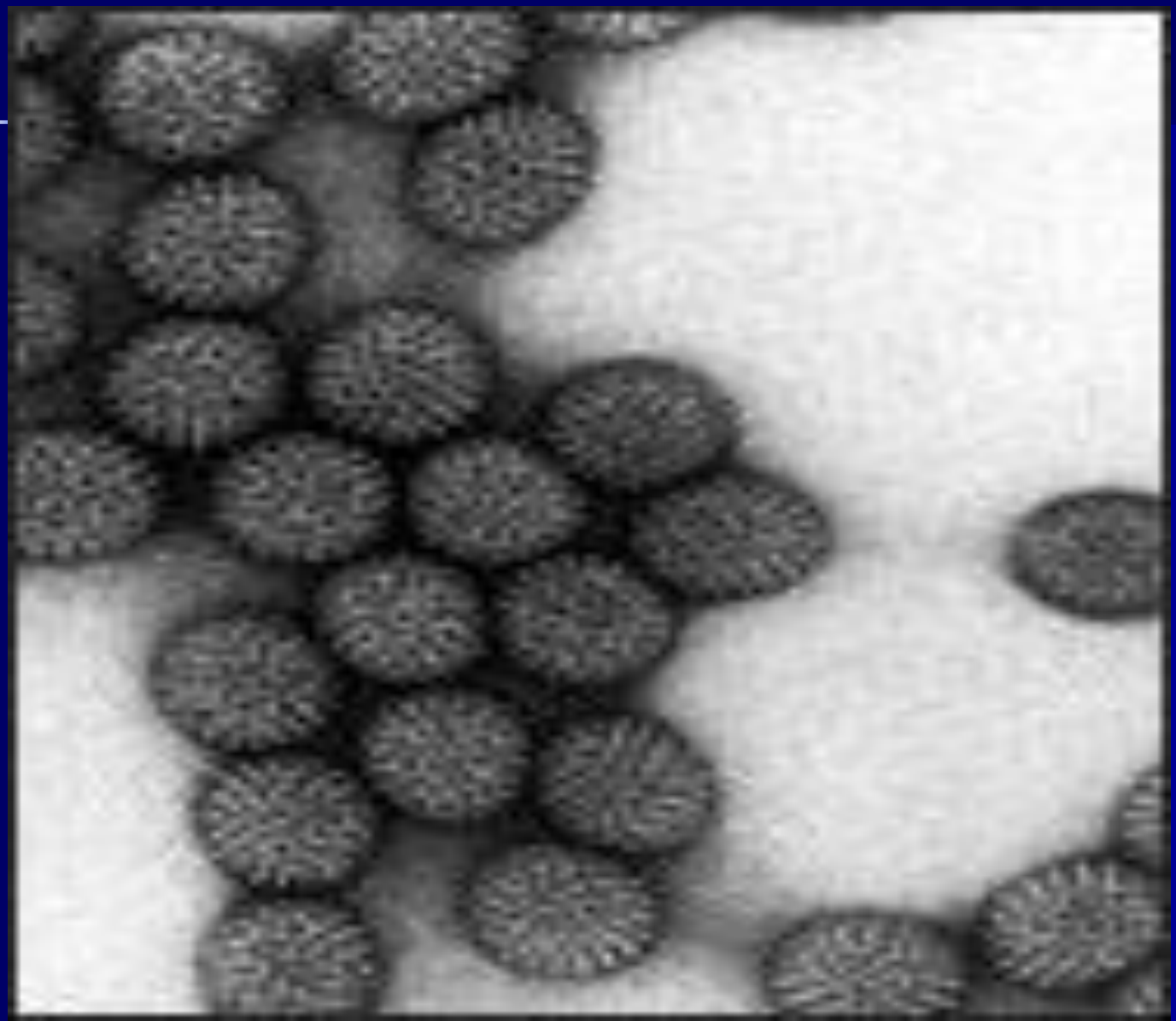
Under a moderately-high magnification of 8000X, this colorized scanning electron micrograph (SEM) revealed the presence of a small grouping of Gram-negative ***Salmonella typhimurium*** bacteria that had been isolated from a pure culture. See PHIL 10986 for a black and white version of this image.



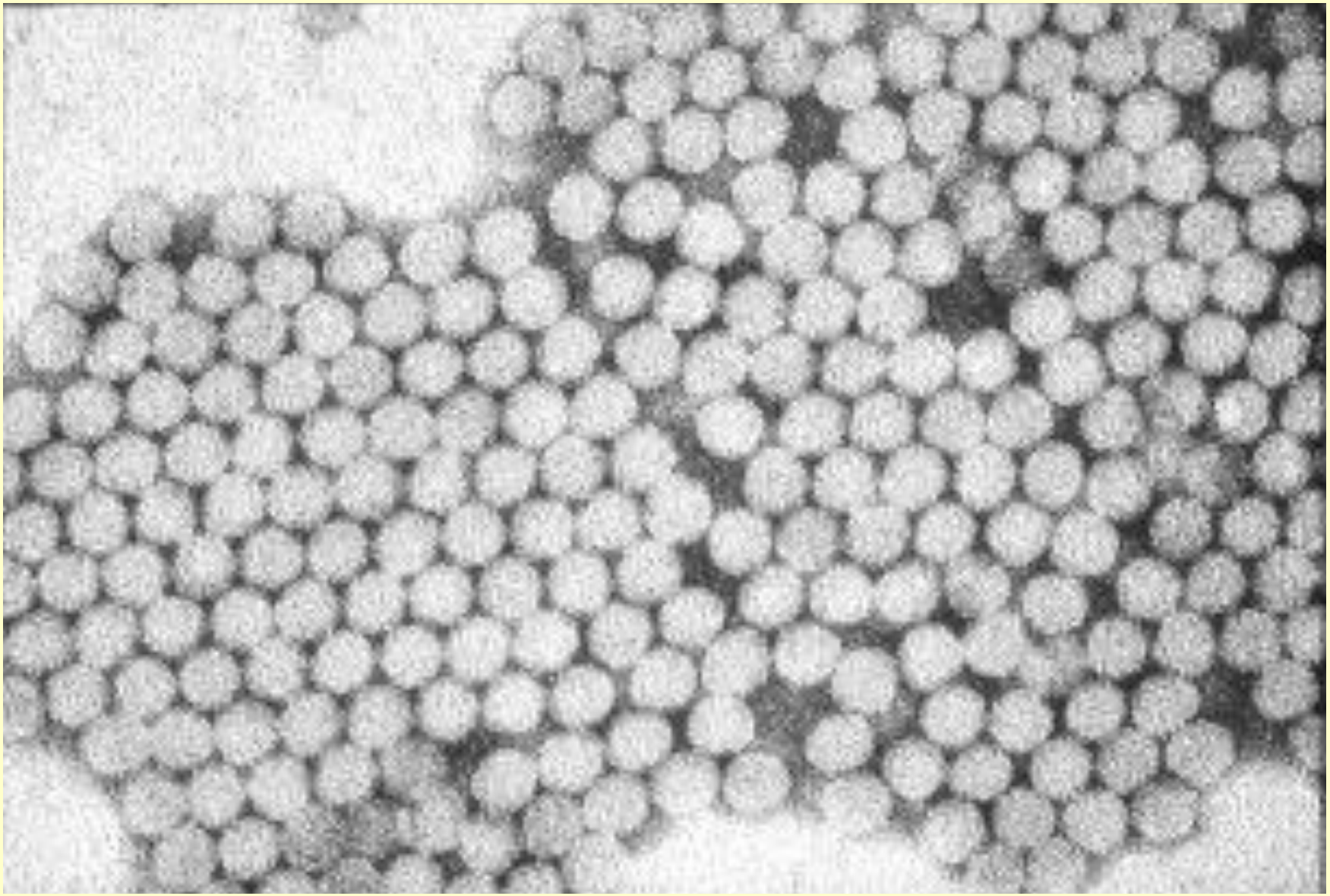
Ziehl-Neelsen stain of 'cords' of ***Mycobacterium tuberculosis*** isolated from a broth culture. Tubercle bacilli aggregate end to end and side to side to form serpentine cords, especially in broth cultures.



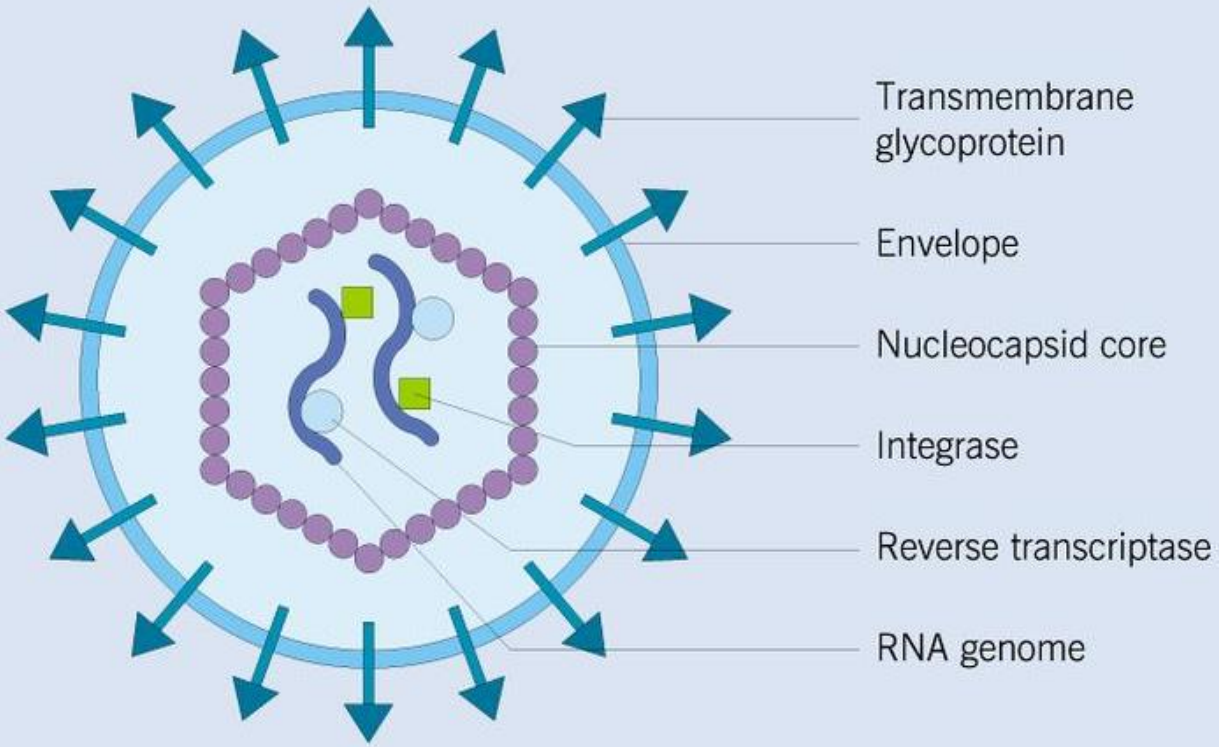
Rotavirus



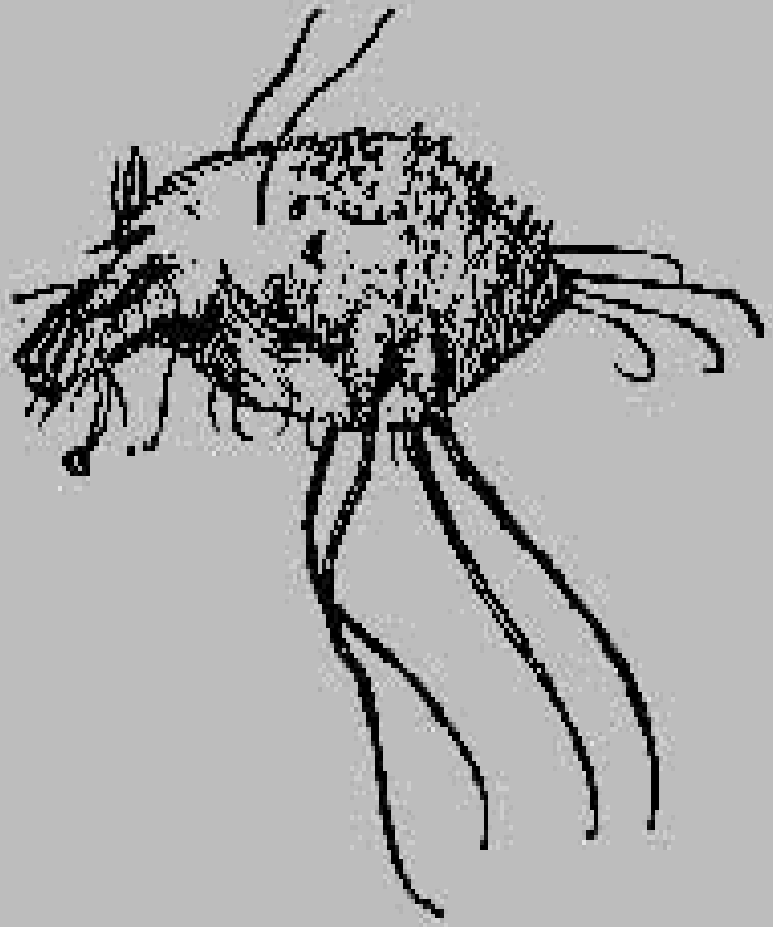
HEPATITIS A VIRUS



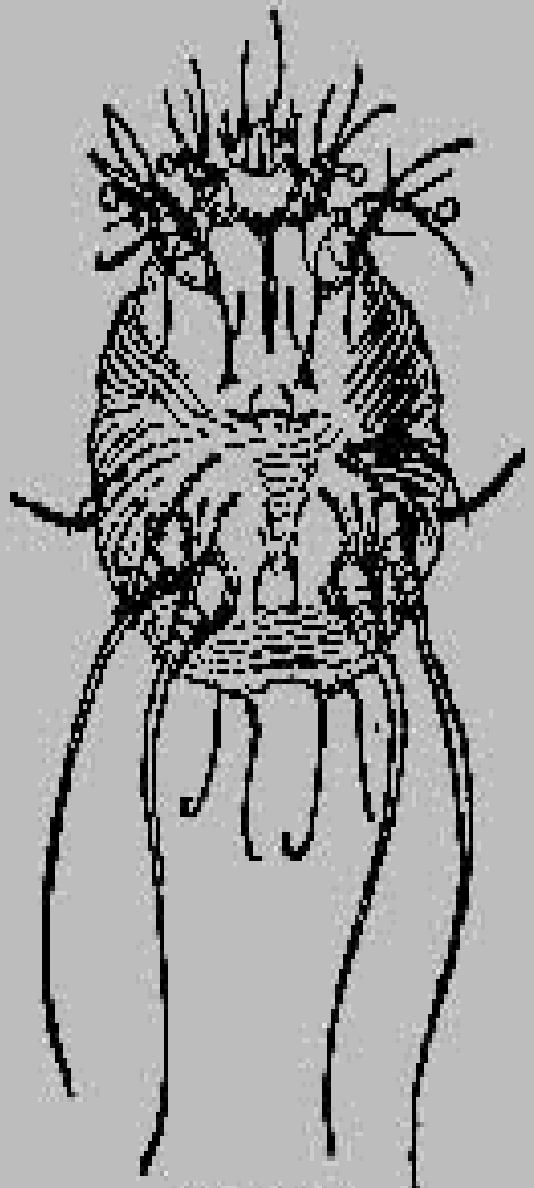
STRUCTURE OF A RETROVIRUS



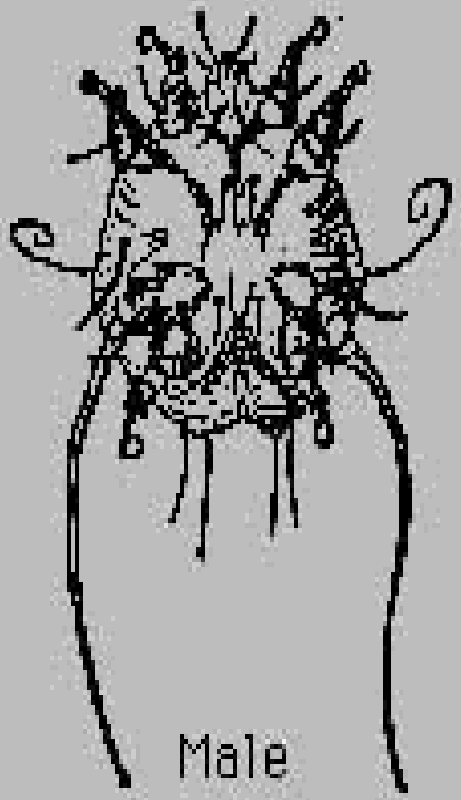
Sarcoptes scabiei



lateral



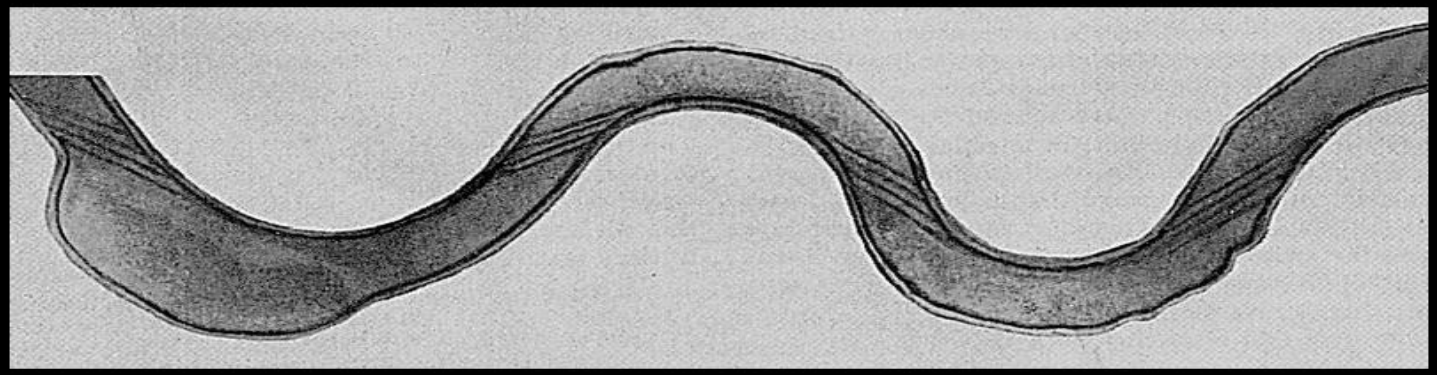
Female



Male

0.4 mm in length

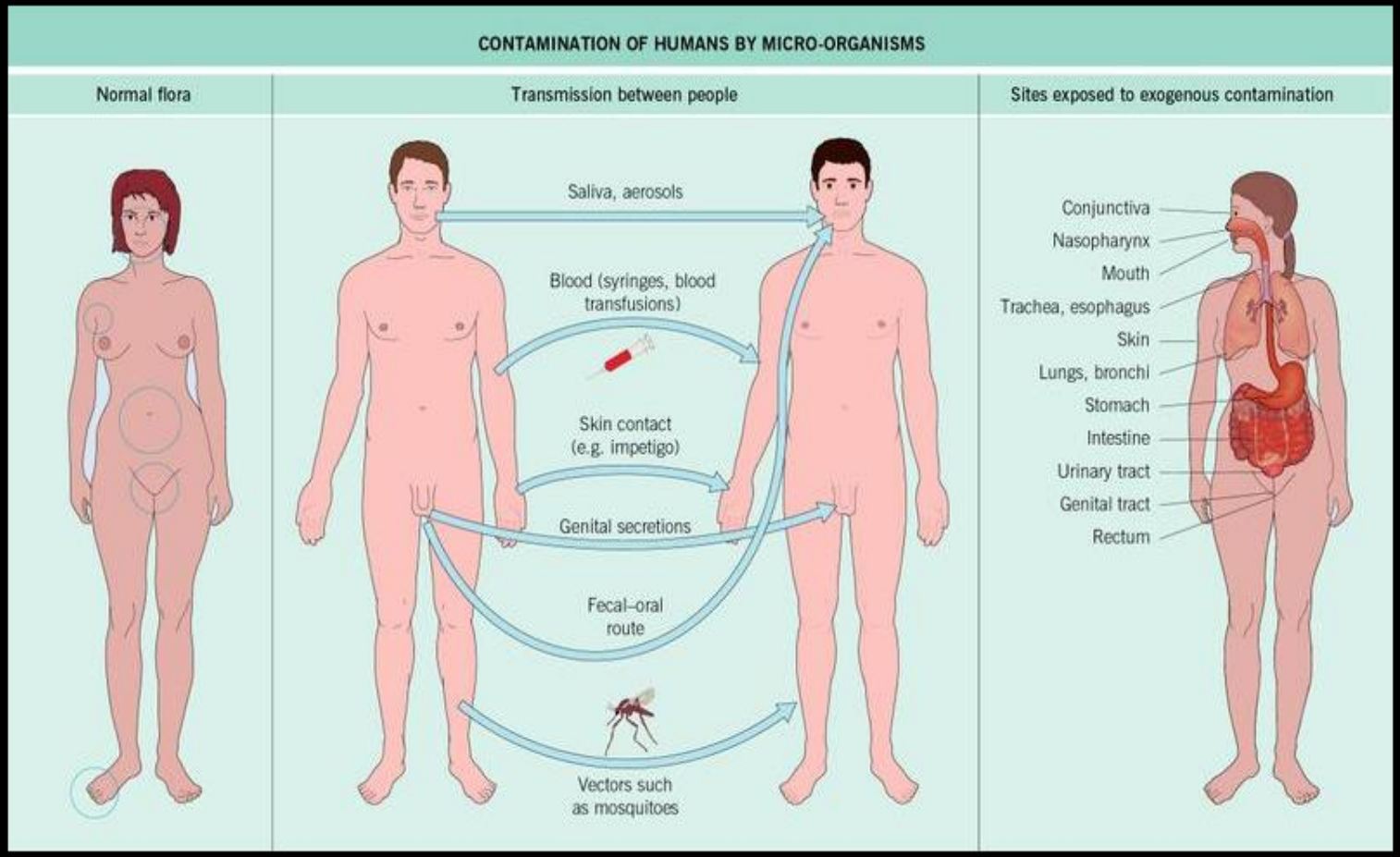
Helical structure of *Treponema pallidum* with the periplasmic flagella.



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

1. the presence of source of infection

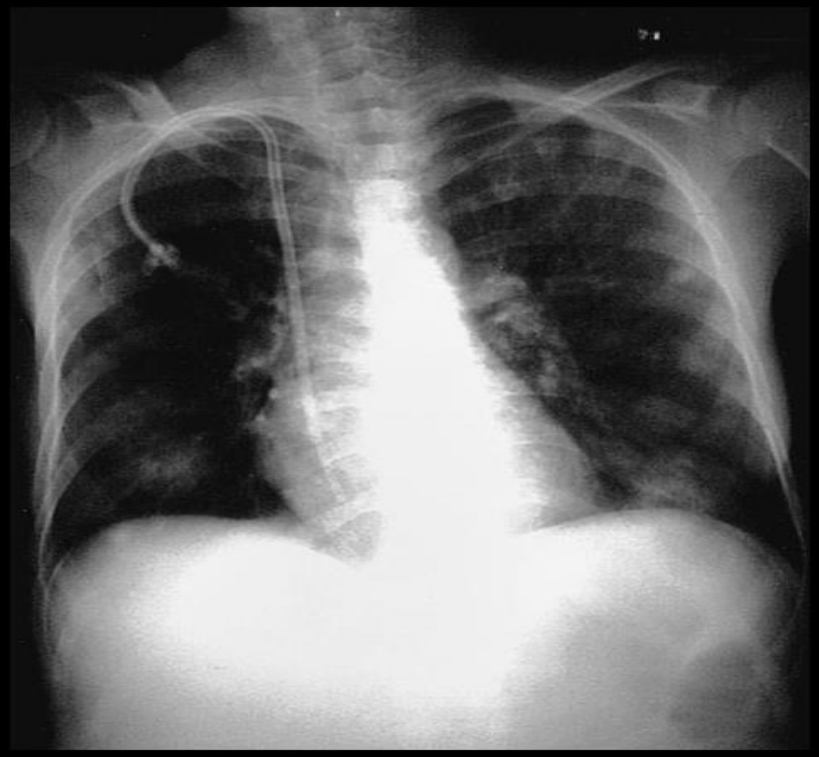
is the site or sites in which a disease agent normally lives and reproduces.

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

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.

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.



2. the metod of transmission

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…)
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Routes of transmission

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

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

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

Host factors :

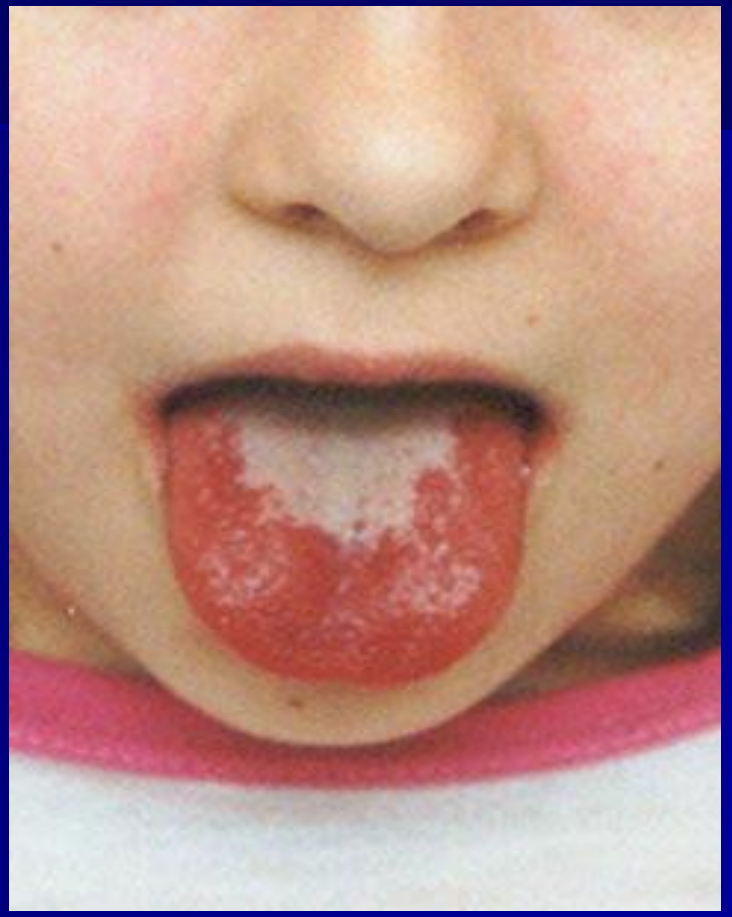
a g e - the very young and the very elderly are more susceptible to infetious diseases than are older children and younger adults

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

Scarlatina (scarlet fever)



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.

- Impetigo in a child.

Varicella (chickenpox)

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

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

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

Primoinfection HIV

Parotitis epidemica (mumps)

Scabies

Crusted or Norwegian scabies in a patient who has AIDS.

Lyme boreliosis (LB)

LB - Typical erythema migrans rash.

In the practical part it is preoccupied with

preventive measures
repressive measures
related to infectious diseases

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i m m u n i t y – natural (nonspecific),
- acquired

THE INFECTION
= 1. source of infection
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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

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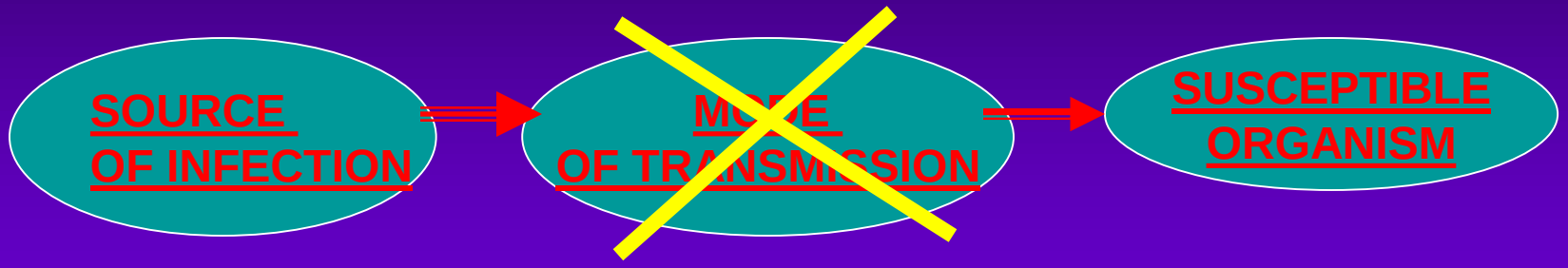
Prevention of infectious diseases

Isolation of patients:

- Dpt. of infectious diseases,
- „high degree of isolation“ (ebola)
- at home,
- barriers nursing technique

Prevention of infectious diseases



HANDWASHING, DISINFECTION OF HANDS

LINEN WASHING,

CLEANING

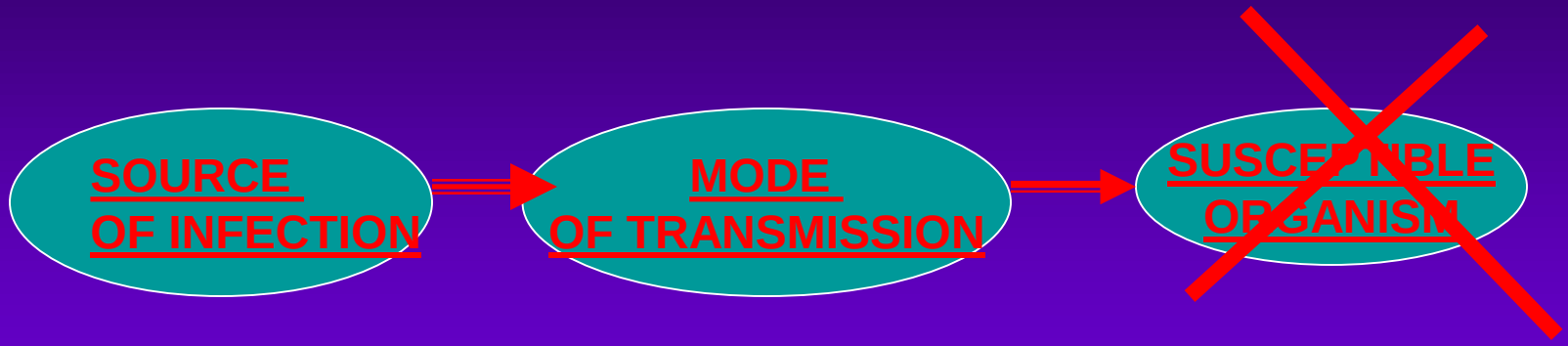
GOOD PREPARING OF FOOD, SAFE WATER……..,

……

DISINFECTION

STERILIZATION

Prevention of infectious diseases



i m m u n i t y

– natural (nonspecific),

- acquired (vaccination)

- **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.

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.

1. Respiratory tract infections

- Influenza
- Avian influenza and other animal influenzas
- Legionnaires' disease
- Severe acute respiratory syndrome (SARS)
- Tuberculosis

2. Sexually transmitted infections, including HIV and blood-borne viruses

- *Chlamydia trachomatis* infection
- Gonorrhoea
- Hepatitis B virus infection
- Hepatitis C virus infection
- HIV/AIDS
- Syphilis

3. Food- and waterborne diseases and zoonoses

- Anthrax
- Botulism
- Brucellosis
- Campylobacteriosis
- Cholera
- Cryptosporidiosis
- Echinococcosis (hydatid disease)
- Shiga toxin/verocytotoxin-producing *Escherichia coli* (STEC/VTEC) infection
- Giardiasis
- Hepatitis A
- Leptospirosis
- Listeriosis
- Salmonellosis
- Shigellosis
- Toxoplasmosis (congenital)
- Trichinellosis
- Tularaemia
- Typhoid/paratyphoid fever
- Variant Creutzfeldt–Jakob disease (vCJD)
- Yersiniosis

4. Emerging and vector-borne diseases

- Malaria
- Plague (*Yersinia pestis* infection)
- Q fever
- Smallpox
- Viral haemorrhagic fevers
- Hantavirus
- Crimean–Congo haemorrhagic fever
- Dengue fever
- Rift Valley fever
- Ebola and Marburg virus
- Lassa fever
- Chikungunya fever
- West Nile fever
- Yellow fever

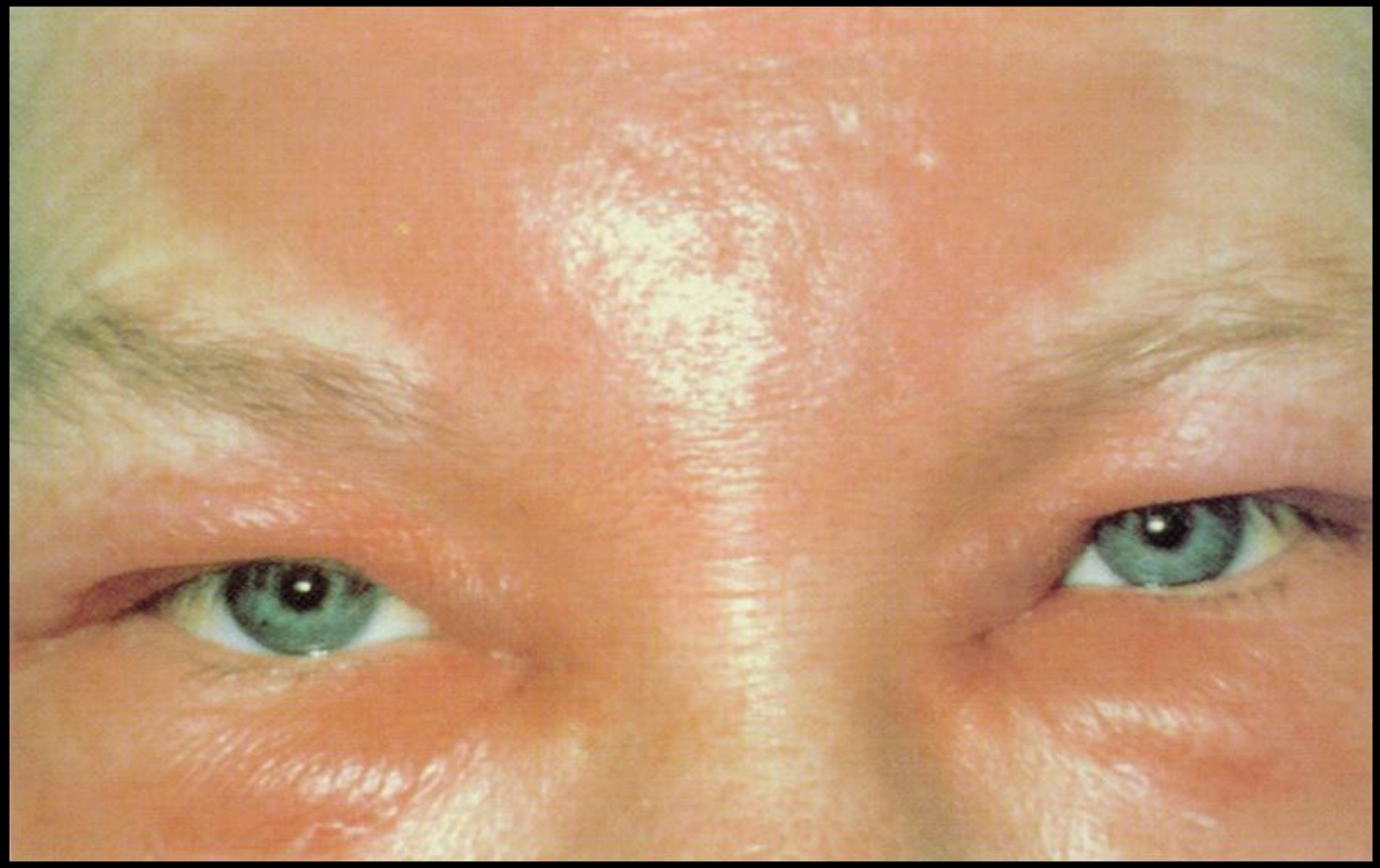
5. Vaccine-preventable diseases

- ✓ Diphtheria
- ✓ Invasive *Haemophilus influenzae* disease
- ✓ Invasive meningococcal disease
- ✓ Invasive pneumococcal disease
- ✓ Measles
- ✓ Mumps
- ✓ Pertussis
- ✓ Polio
- ✓ Rabies
- ✓ Rubella
- ✓ Tetanus

6. Antimicrobial-resistant pathogens and healthcare-associated infections

- Antimicrobial resistance
- Antimicrobial consumption
- Healthcare-associated infections - HAI

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



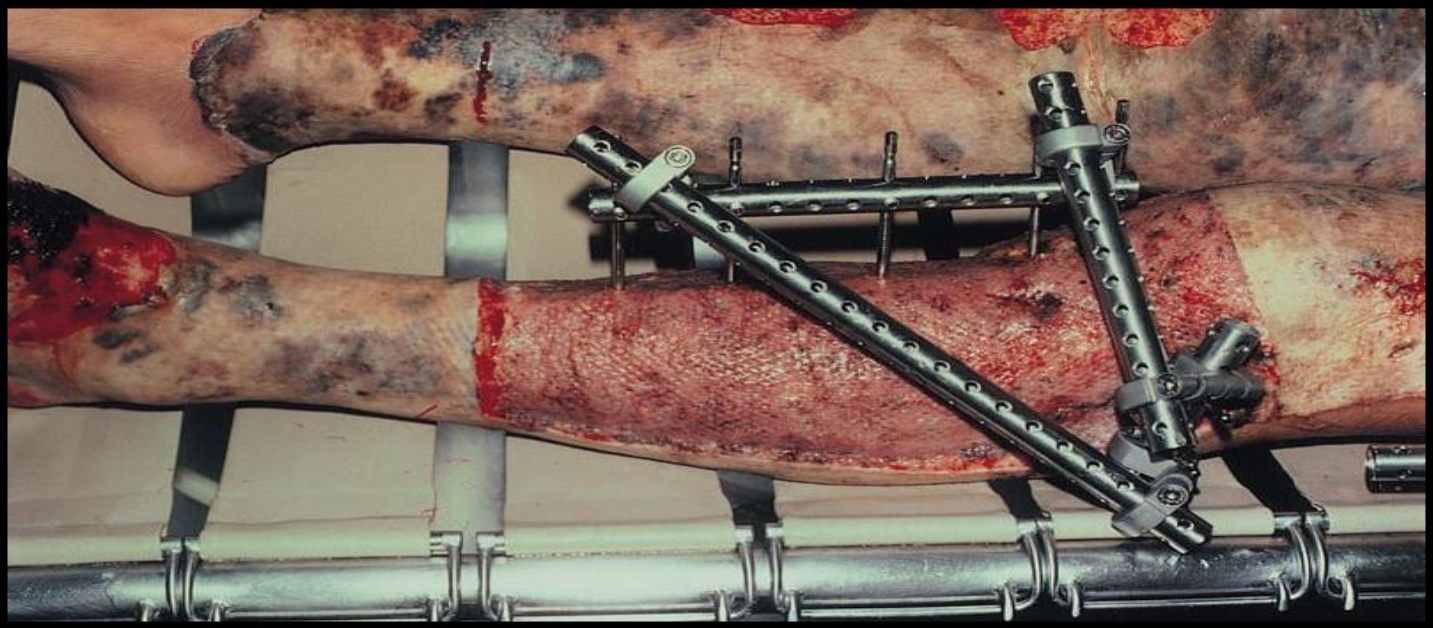
Erysipelas. Note the sharp demarcation of the affected skin.

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

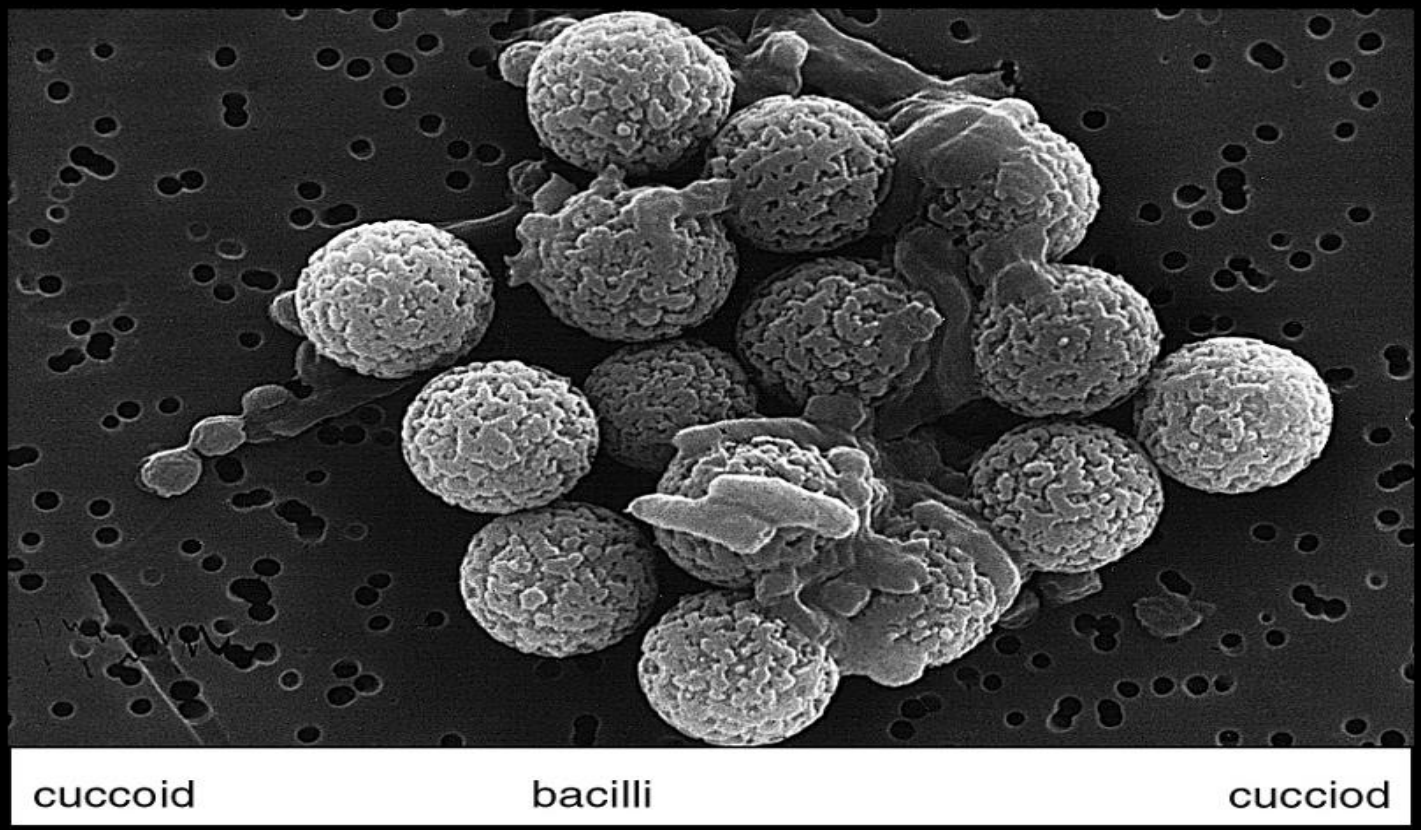
Mixed culture of two morphotypes of Enterobacteriaceae on blood agar plate (*Escherichia coli* and *Salmonella* spp.).

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.



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.

Giemsa stain of blood with *Borellia burgdorferi*.

Tick - Ixodes ricinus

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

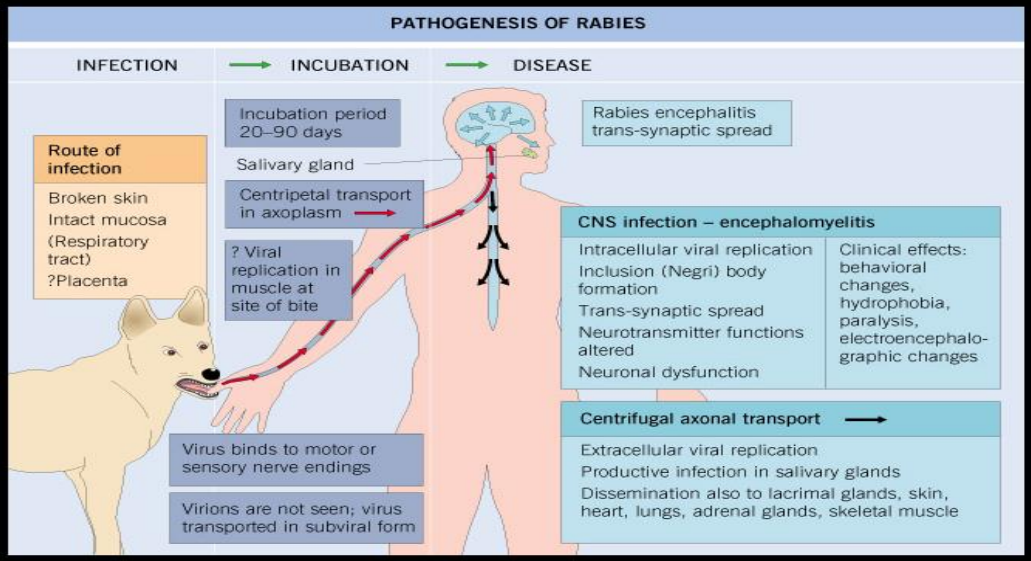
Francisella tularensis

Tularemia

Tularemia

Hlístice Trichinella spiralis

Pathogenesis of rabies.



Headlines

Human cases of Q fever associated with 'fresh cell therapy'

- 16 Oct 2015
- A new rapid risk assessment has been published on the risk of Q fever associated with 'fresh cell therapy' following seven such cases being reported in Germany.
- Six human cases of Q fever were associated with so-called 'fresh cell therapy' performed in Germany in May 2014. These cases reconfirm the risk of infectious disease transmission through xenotransplantation.
- The potential recipients of fresh cell therapy or other products of animal origin, should be informed of the risks. Organisations that are active in donation and transplantation of substances of human origin should be aware that instances of fresh cell therapy occur, because potential donors who have received animal cells as part of such therapy should be rejected for donation. A number of European countries are in the process of regulating the practice and others may consider also doing so by, for example, establishing national systems for monitoring and traceability of xenotransplantation.

- **Fresh cell therapy** despite unproven efficacy and numerous associated risks, continues to be offered and used. Fresh cells are usually isolated from the homogenised organs and tissues of sheep foetuses and placentas, The live cells or extracts are injected into the recipient in order to obtain a purported revitalising effect. Often, these therapies are promoted as anti-aging treatments, treatment for chronic diseases, age-related disorders (such as arteriosclerosis) or as an alternative treatment for cancer.
- **Q fever** is an infectious disease caused by bacteria called Coxiella burnetii that affects both humans and animals. Q fever can be a mild illness but symptoms include sudden headaches, fever, chills, muscle soreness and, in some cases, pneumonia. Some symptoms such as fatigue can be long-lasting.
- **Complications**
- In a very small number of cases (around 1%), Q fever leads to a more serious illness known as chronic Q fever, sometimes after a number of years. The most common symptom of chronic Q fever is inflammation of the inner lining of the heart (endocarditis), which can be deadly if not treated.