MUNI
MED

Basic data in epidemiology of infectious diseases

Three parts of the chain of infections´ dissemination; their role in the primary prevention of infectious diseases

aZLHE0711p,c – October 6,2021

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Historical overview

165 -190 A.D. **ANTONINE SMALLPOX PLAQUE**

5 mil. death

541 – 542 **PLAQUE OF JUSTINIAN** *Yersinia pestis*

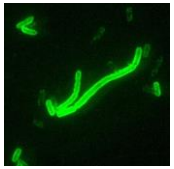
2 mil. death

Pre-host rats, fleas

735 – 737 **JAPANESE SMALLPOX EPIDEMIC** *Variola major* virus

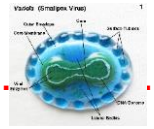
2 mil. death

1347 – 1351 **BLACK DEATH** *Yersinia pestis*



50 mil. death

1520 ---------- **1980 NEW WORLD OUTBREAK** *Variola major* virus



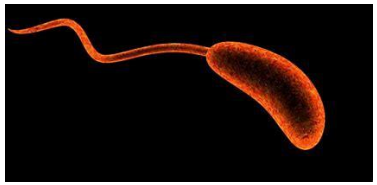
56 mil. death

1980 ERADICATION OF SMALLPOX

1629 -1631 **ITALIAN PLAQUE** *Yersinia pestis*

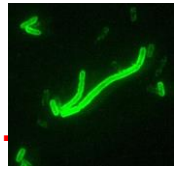
1 mil. death

1817 – 1824 **CHOLERA PANDEMICS** *Vibrio cholerae*



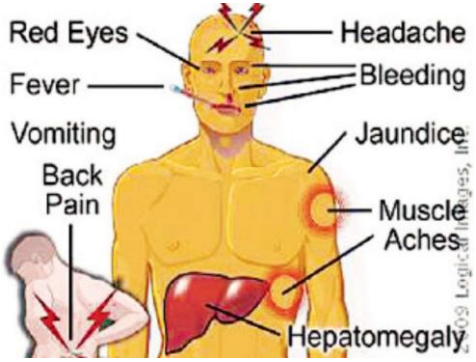
1 mil. death

1885 **THIRD PLAQUE** *Yersinia pestis*



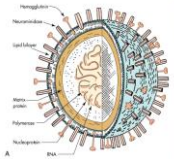
12 mil. death

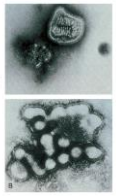
Late 1800s **YELOW FEVER** *Yelow fever virus*



100 000 – 150 000

1889-1890 **RUSSIAN FLU** **H2N2**; Pre-host - avian origin





1 mil. death

1918 – 1919 **SPANISH FLU** **H1N1;** Pre-host -pigs

40 – 50 mil. death

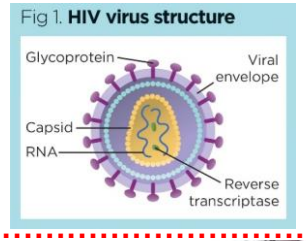
1957 -1958 **ASIAN FLU** **H2N2;** Pre-host – avian origin

1 – 2 mil. death

1968 - 1970 **HONG-KONG FLU** **H3N2**

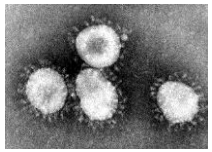
1 mil. death

1980 ---------- present **HIV/AIDS**



36 mil. death

2002-2003 **SARS** (*Severe Acute Respiratory Syndrome*) *Coronavirus*



770 death

Pre-host bats, civests

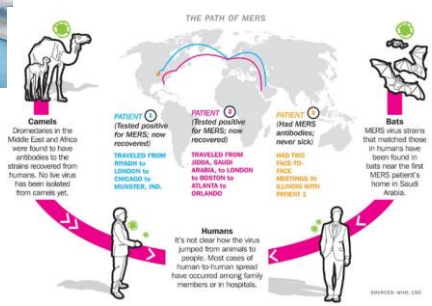
2009 – 2010 **SWINE FLU**

200 000 death

2014 -2016 **EBOLA**

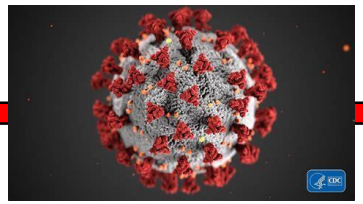
11 000 death

2014 --- present **MERS** (***MERS***-*CoV – Middle East Respiratory Syndrome Coronavirus)*



866 death

2019 -- present **COVID 19**



..... **222 407 000 CASES - 4 593 000 death**

(Situation update 9.9. 2021)

CZ - více než 1 682 000 případů; 30 413 úmrtí

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
(collection of all date describing the occurence 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 or prevention in a group of people)

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

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

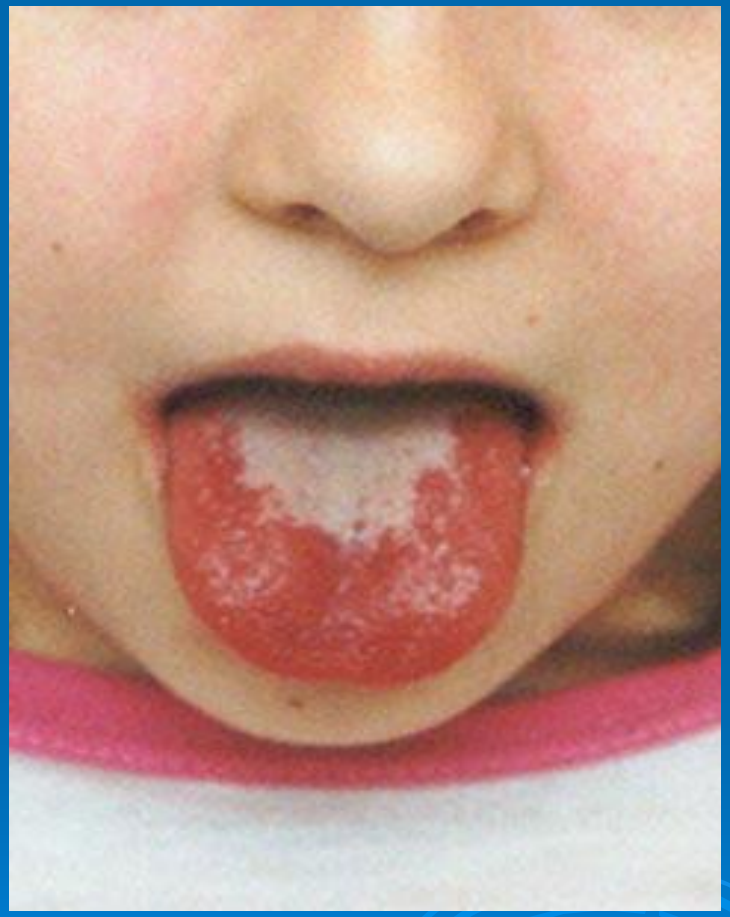
Modern infectious disease epidemiology

Varicella (chickenpox)

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

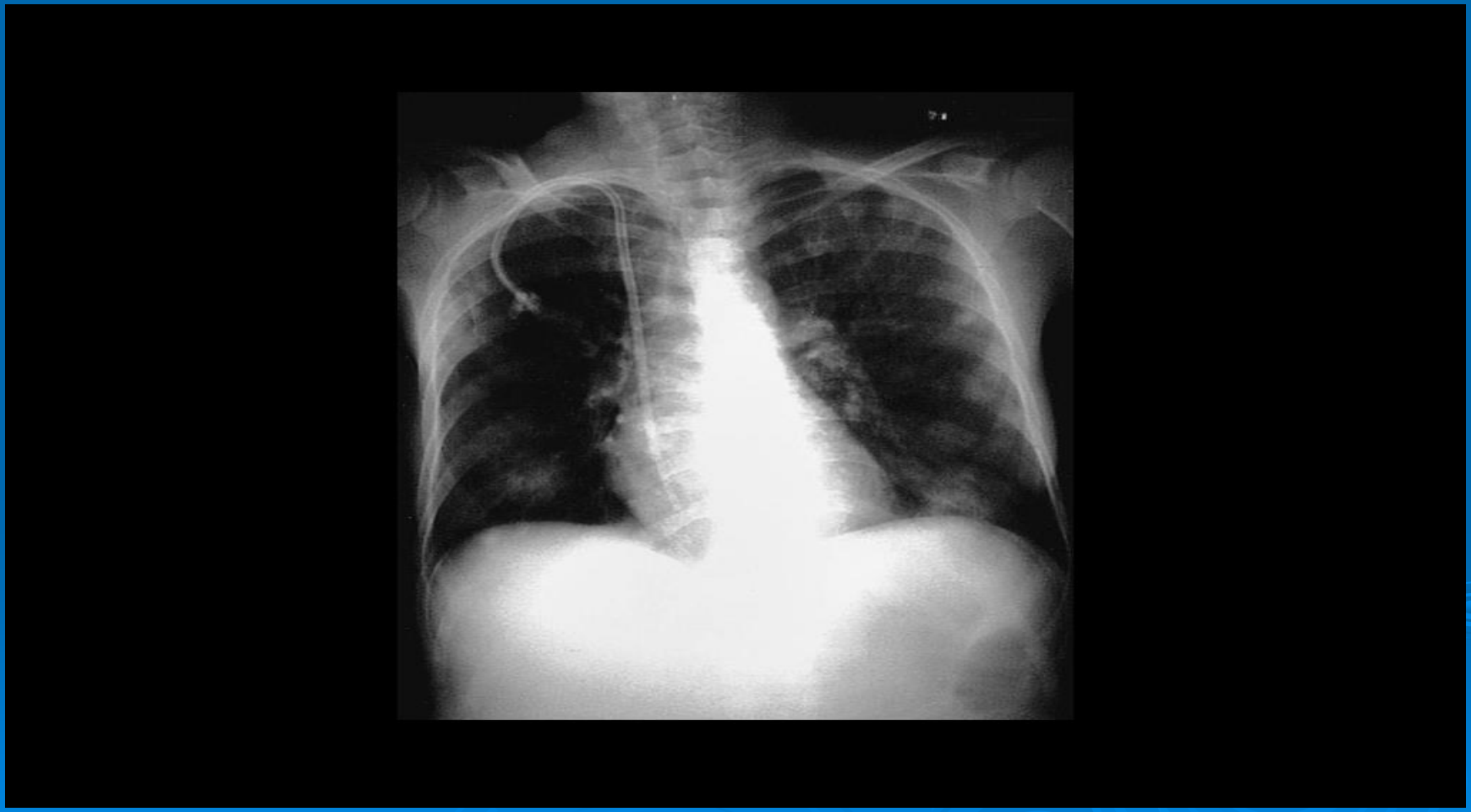
Erysipelas. Note the sharp demarcation of the affected skin.

Scarlatina (scarlet fever)



- 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.



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

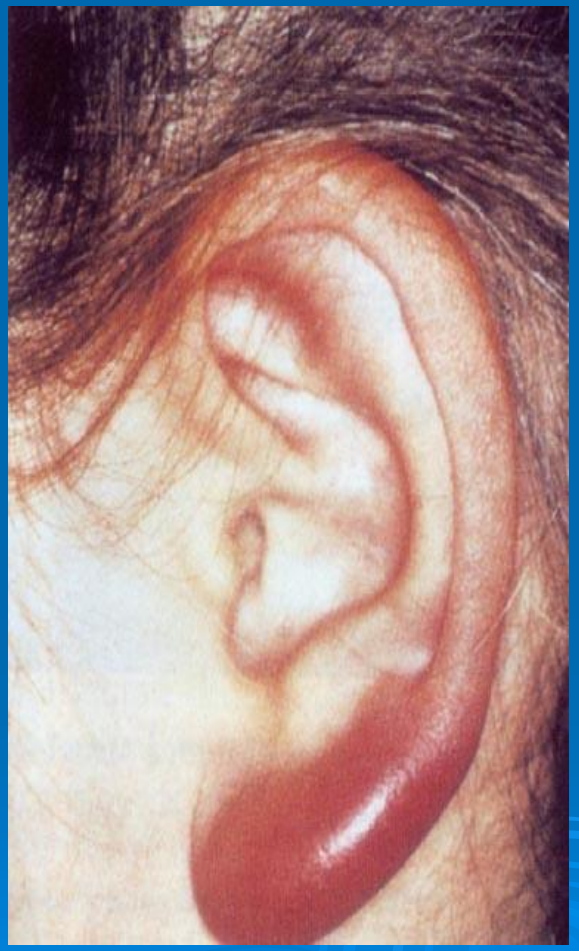
Parotitis epidemica (mumps)

Primoinfection HIV

Secondary syphilis with typical skin rash.

Gonococcal urethritis.

Lyme boreliosis (LB)



LB - Typical erythema migrans rash.

Scabie

Crusted or Norwegian scabies in a patient who has AIDS.

Tularemia

Tularemia

Terminology and Definitions

- Chain of infection
- Host (source)
- Transmission
  - Direct
  - Indirect
  - Biologic
  - Vertical
- Susceptible host

- Case definition
- Incidence and prevalence
- Attack rate
- Sporadic disease
- Endemic disease
- Epidemic(outbreak)
- Pandemic disease
- Eradication
- Elimination

- Immunity passive, active
- Individual immunity
- Herd immunity
- Virulence
- Incubation period
- Infectivity period
- Latent period
- Nosocomial infection
- Opportunistic infection

Zoonosis

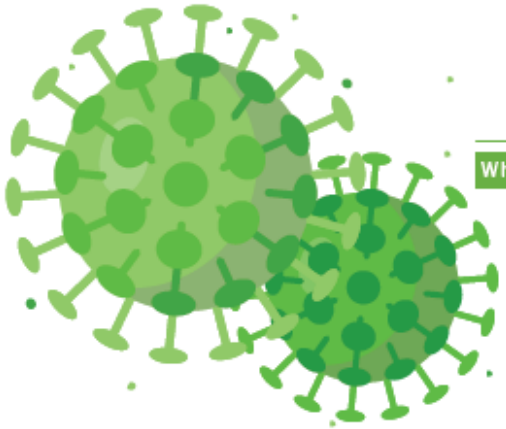
COVID-19

Disease caused by the SARS-CoV-2 virus

Novel coronavirus

Coronaviruses are viruses that circulate among animals but some of them are also known to affect humans.

The 2019 novel coronavirus was identified in China at the end of 2019 and is a new strain that has not previously been seen in humans.



Prevention

When visiting affected areas

- Avoid contact with sick people
- Wash your hands with soap and water
- If you develop cough, use a medical face mask

Wherever you travel apply general hygiene rules

Symptoms

- FEVER
- COUGH
- DIFFICULTY BREATHING
- MUSCLE PAIN
- TIREDNESS

Transmission

VIA RESPIRATORY DROPLETS

2–14 days

estimated incubation period

ecdc.europa.eu/en/novel-coronavirus-china

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 : a g e , 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 (nonspecific),
- acquired

THE INFECTION

= 1. **source of infection**

.....

THE CAUSATIVE AGENT OF INFECTION

(bacteria, viruses, fungi, prions, protozoa)

Organism characteristic:

infectivity – capacity to multiply in host

pathogenicity – capacity to cause disease in host

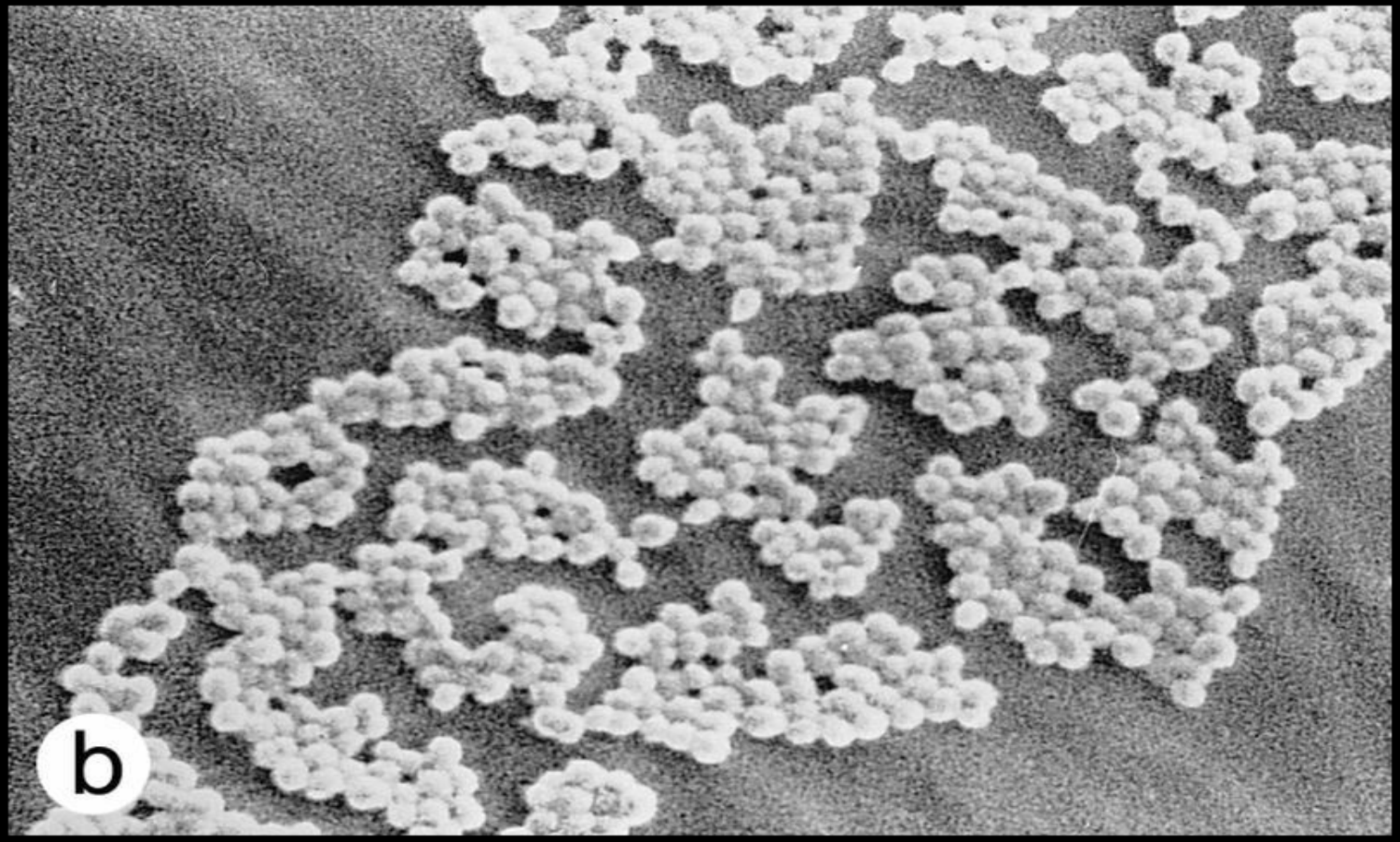
virulence - pathogenicity in a specific host

immunogenicity – capacity to induce specific and lasting immunity in host

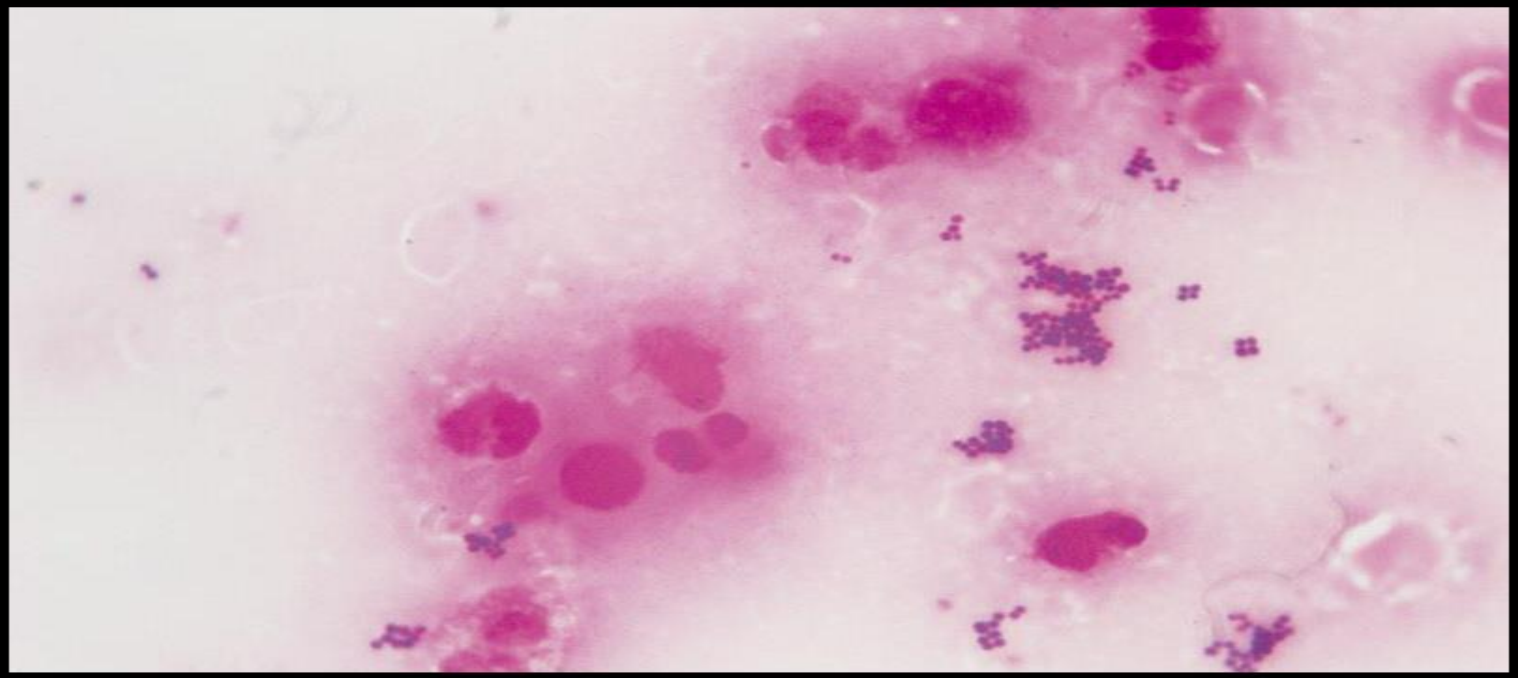
antigenic stability – can induce long-life immunity

resistance - in environment

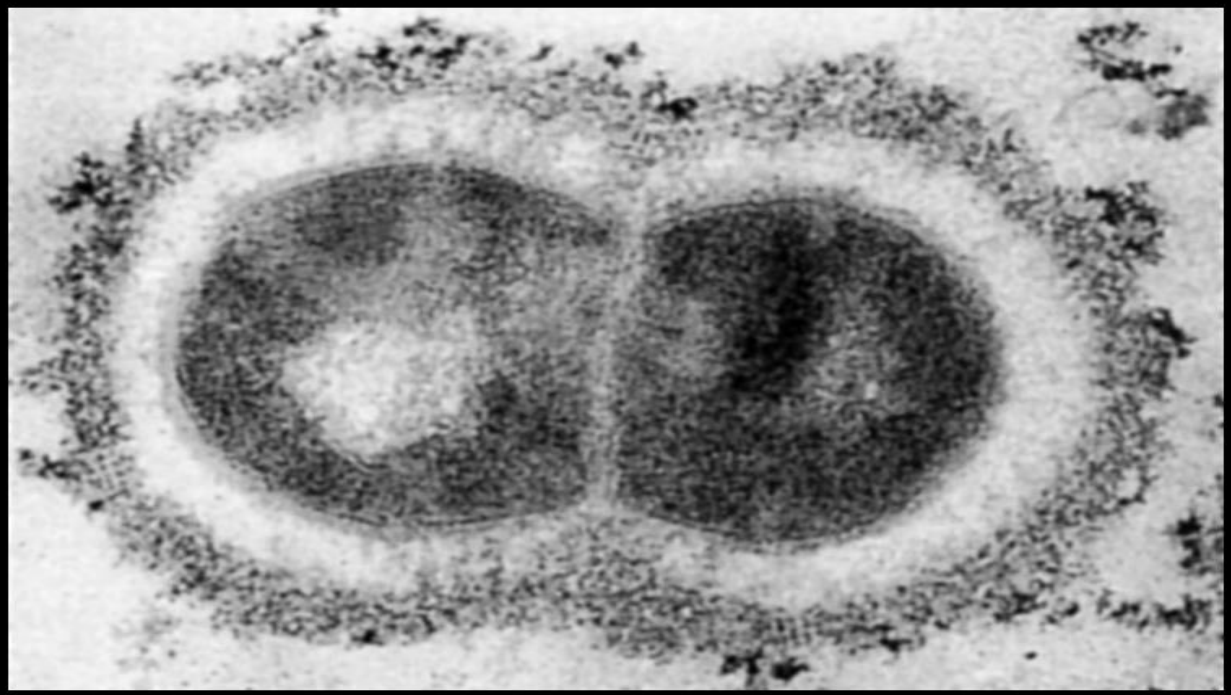
Slime-producing coagulase-negative staphylococci. Scanning electron micrograph of the surface of an intravascular catheter incubated *in vitro* with (a) slime-producing and (b) nonslime-producing strains of *Staphylococcus epidermidis*. With permission from Christensen.[9]



Staphylococcus aureus

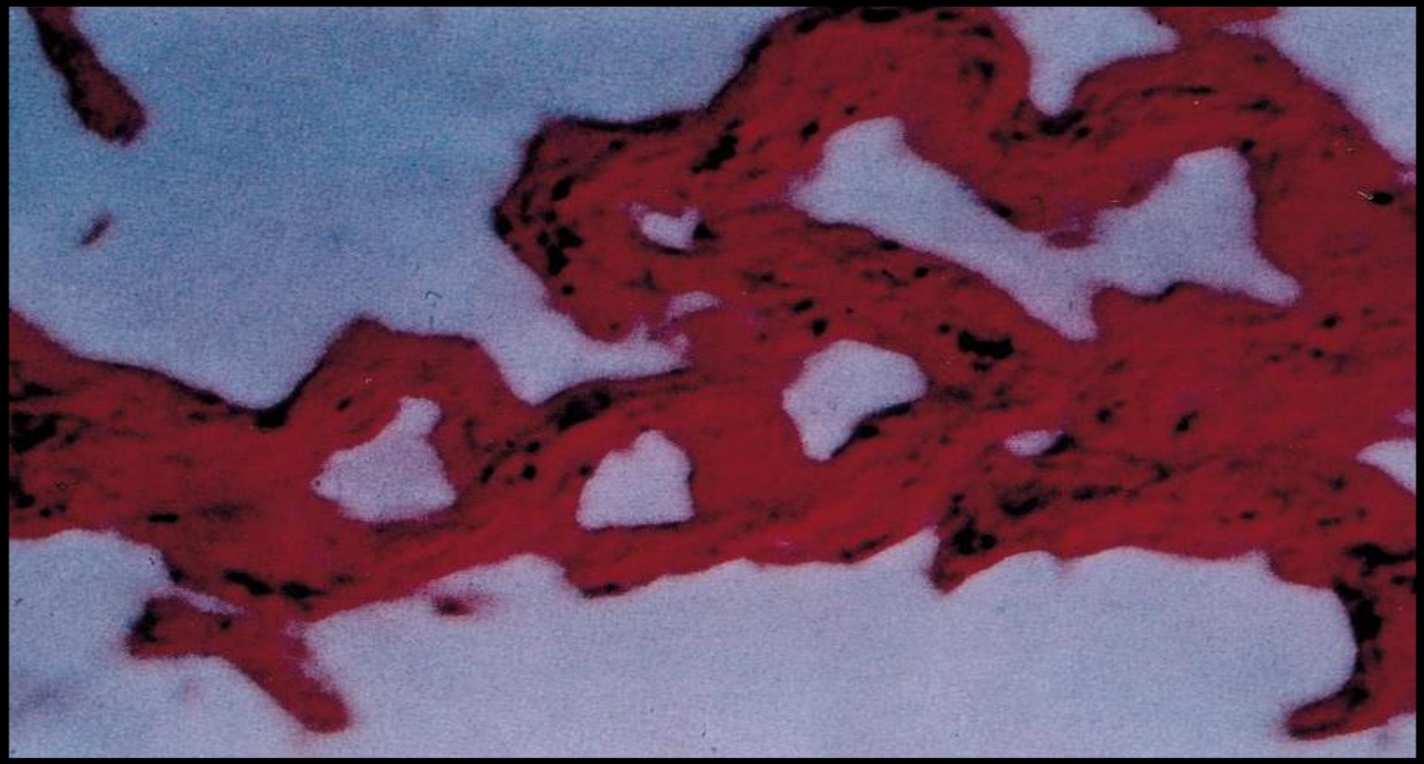


- β-Hemolytic streptococci group A on a blood agar plate. Note the clear b-hemolytic zone.



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

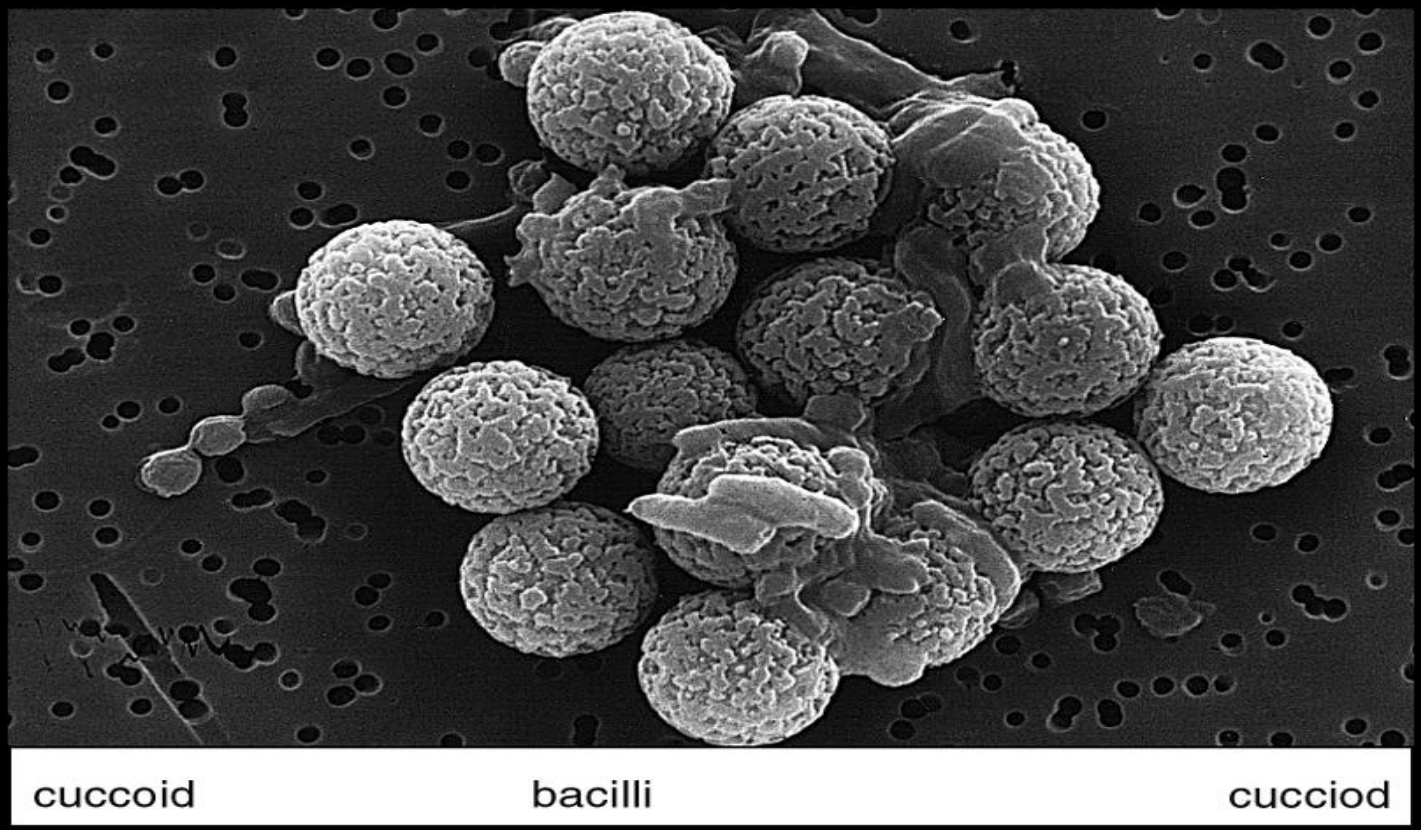
Ziehl-Neelsen stain of 'cords' of ***Mycobacterium tuberculosis*** isolated from a broth culture. Tubercle bacilli aggregate end to end and side to side to form serpentine cords, especially in broth cultures.



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.**

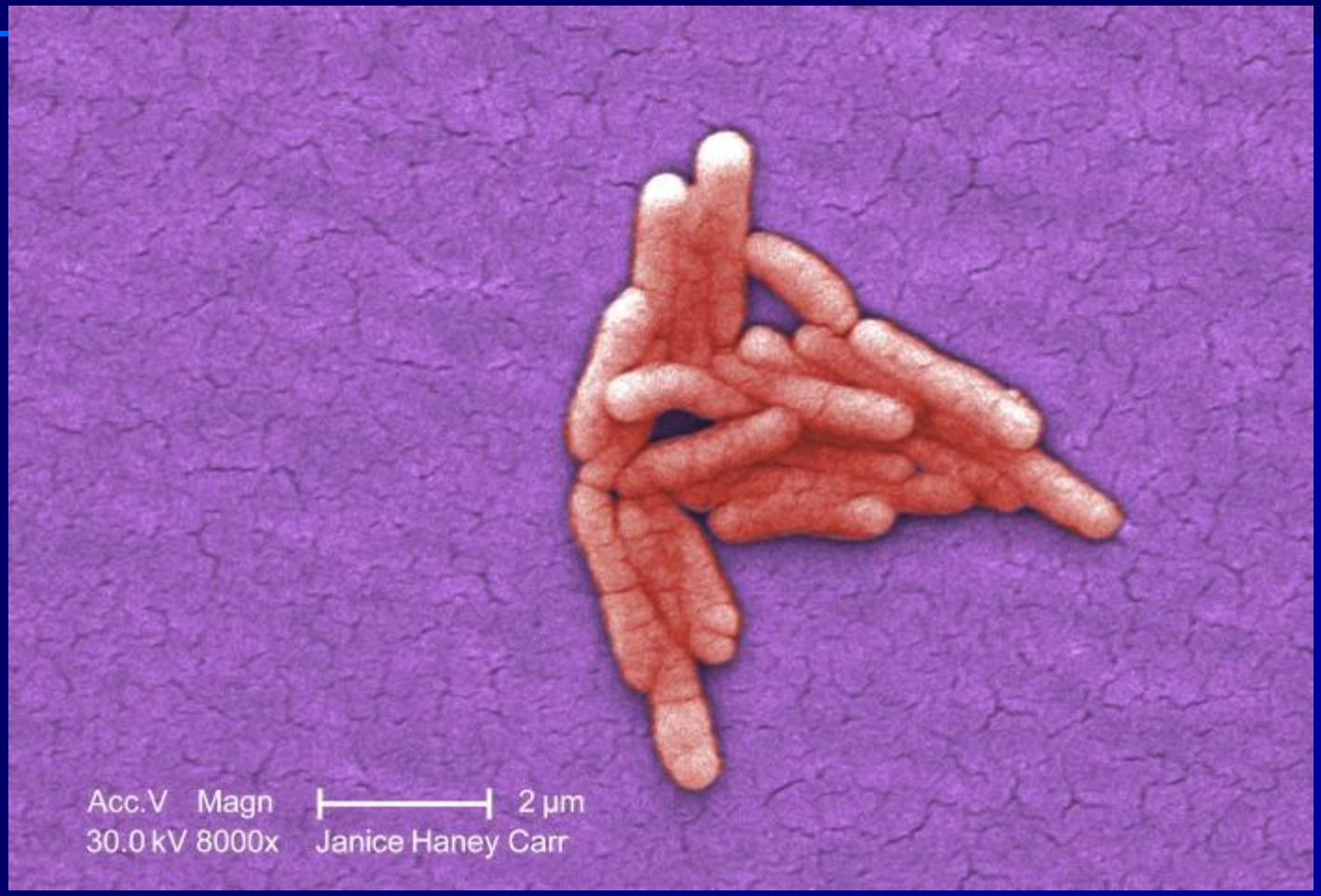
Cultured *Helicobacter pylori* in coccoid and bacilli forms, bound to immunomagnetic beads.

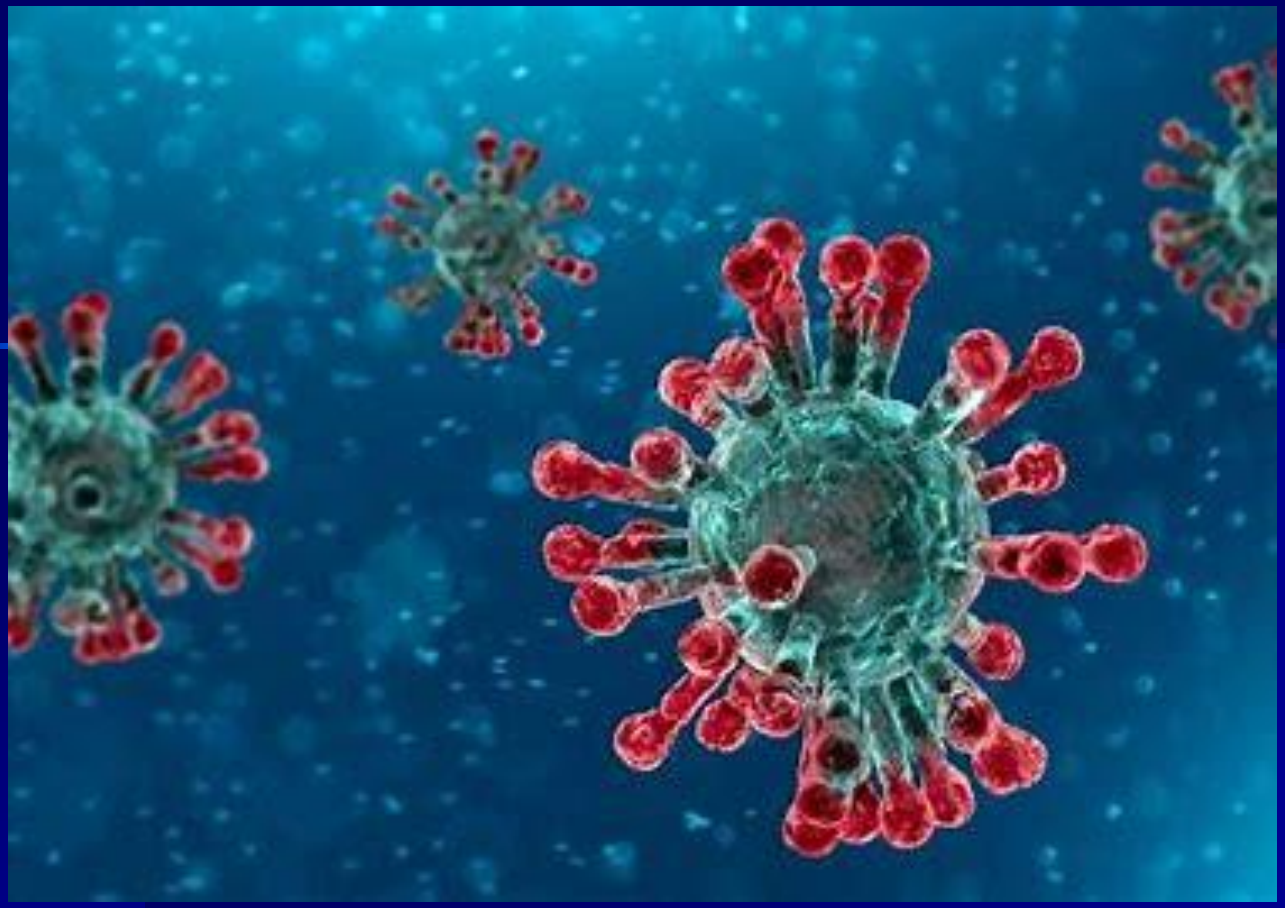


Obtained after an outbreak, this micrograph depicts Gram-positive *Clostridium difficile* bacteria.

Source: CDC

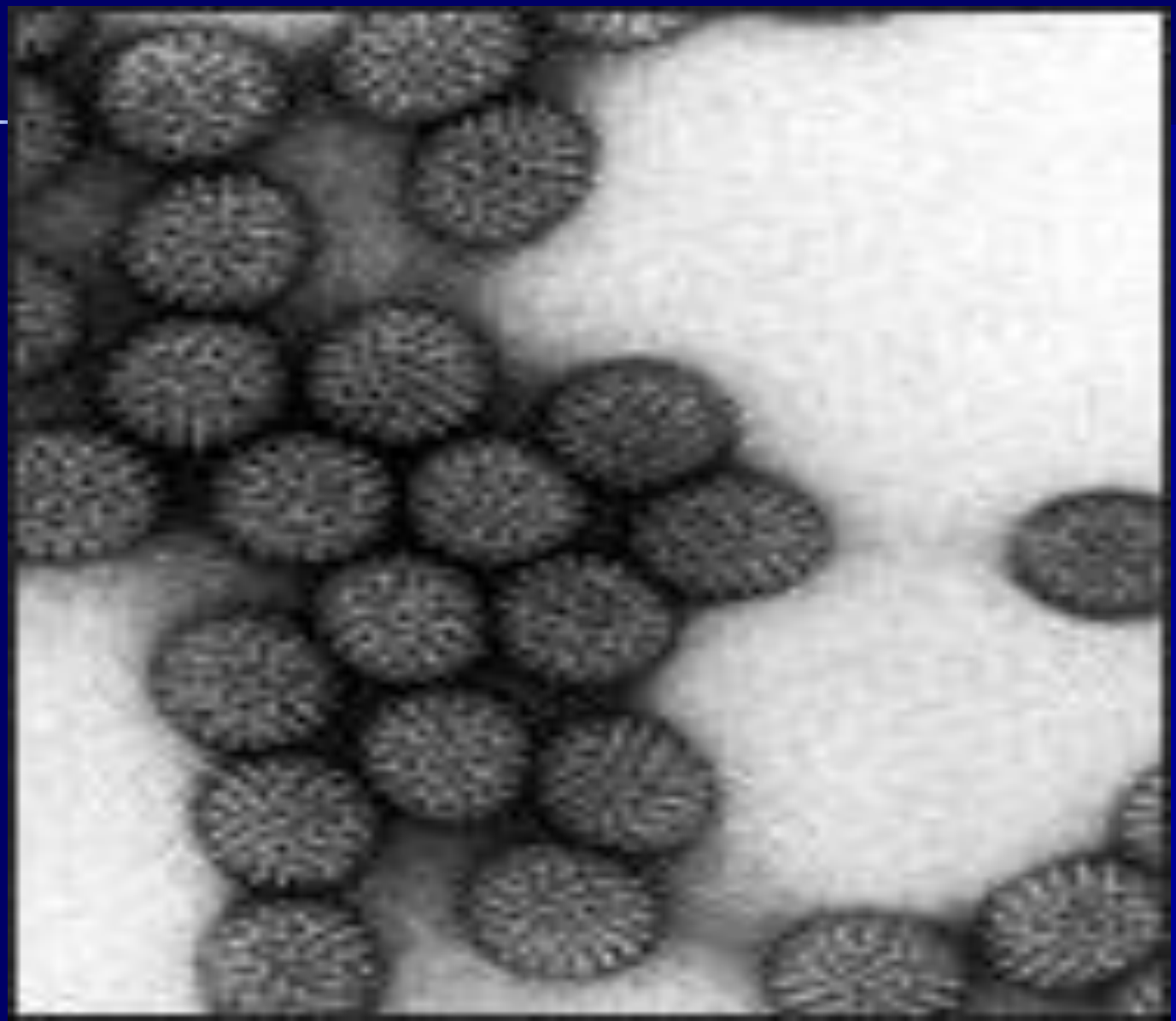
Under a moderately-high magnification of 8000X, this colorized scanning electron micrograph (SEM) revealed the presence of a small grouping of Gram-negative ***Salmonella typhimurium*** bacteria that had been isolated from a pure culture. See PHIL 10986 for a black and white version of this image.



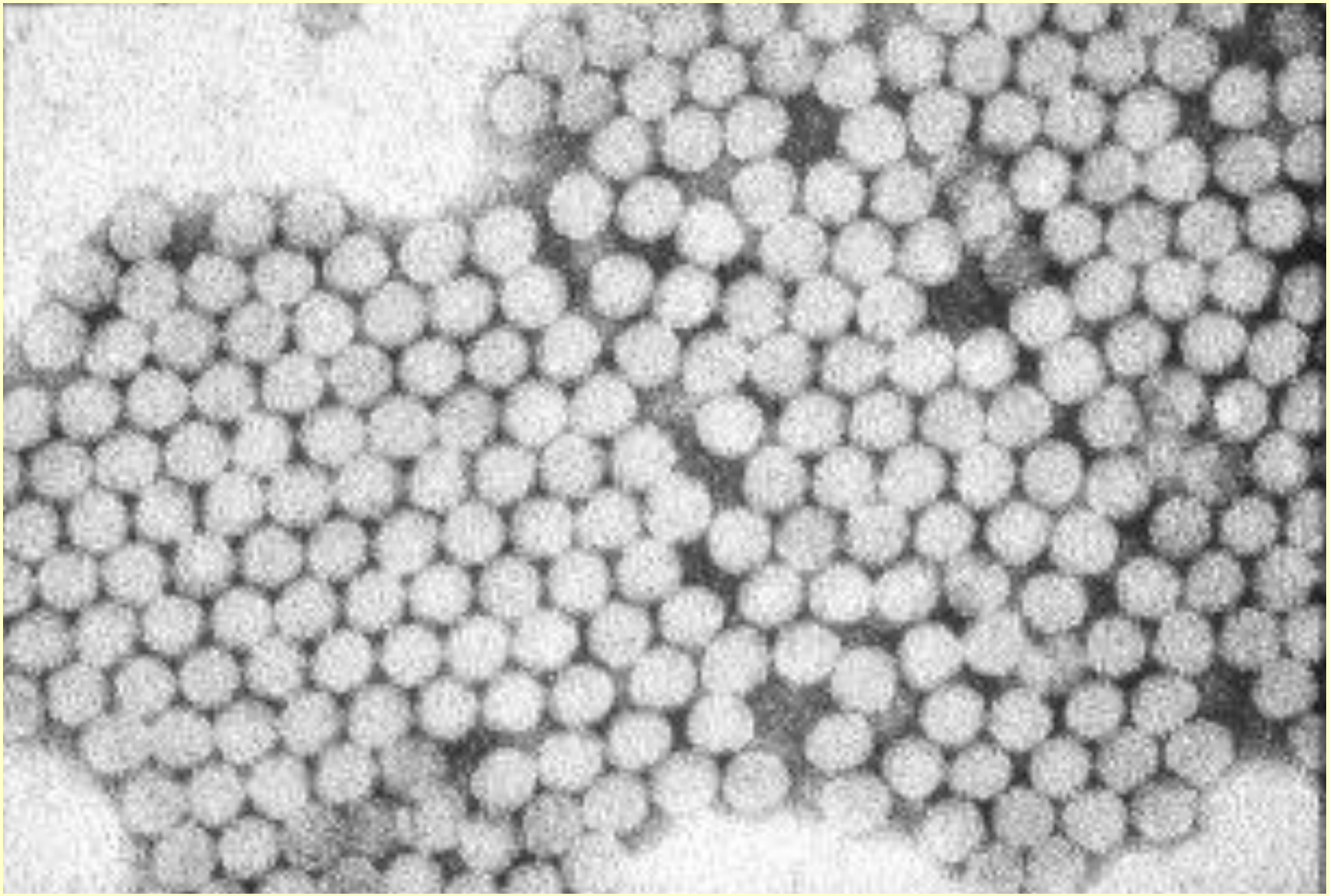


Group: Group IV ((+)ssRNA)
Order: Nidovirales
Family: Coronaviridae
Subfamily: Coronavirinae
Species: Human Coronavirus

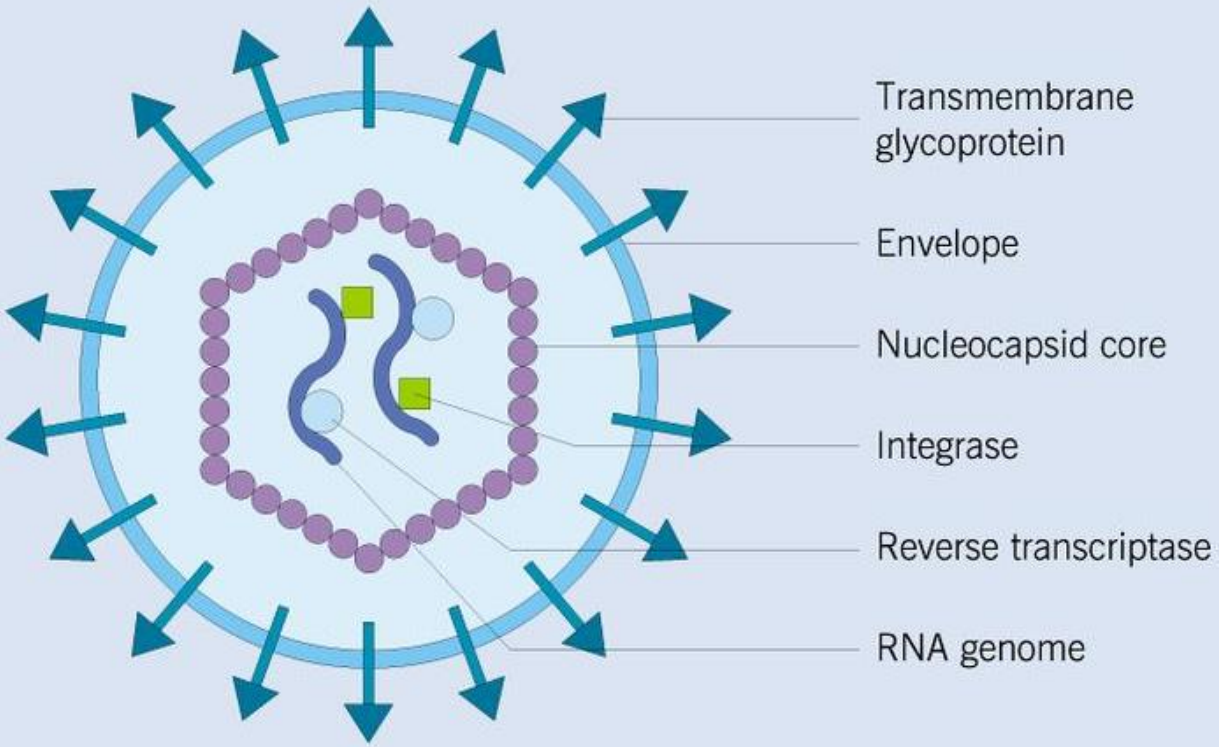
Rotavirus



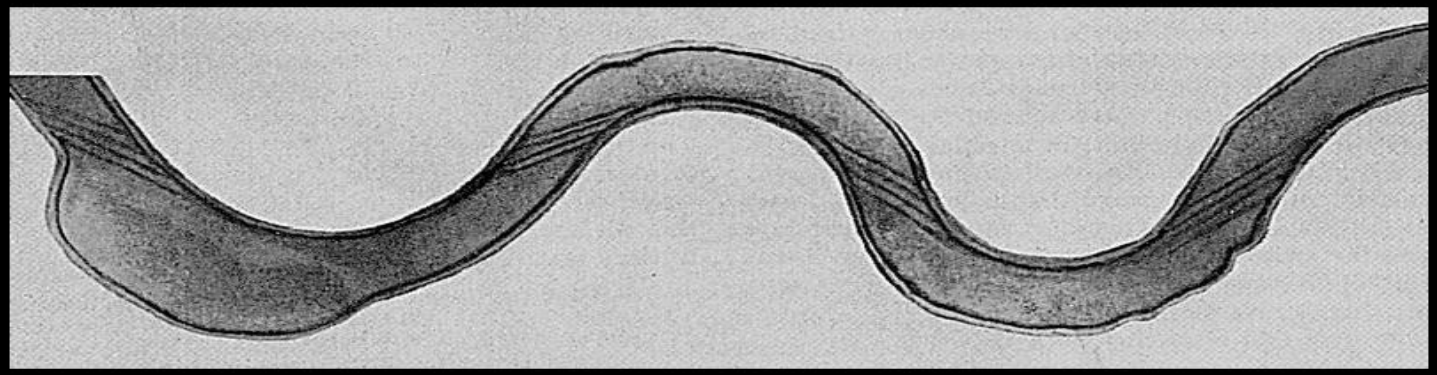
HEPATITIS A VIRUS



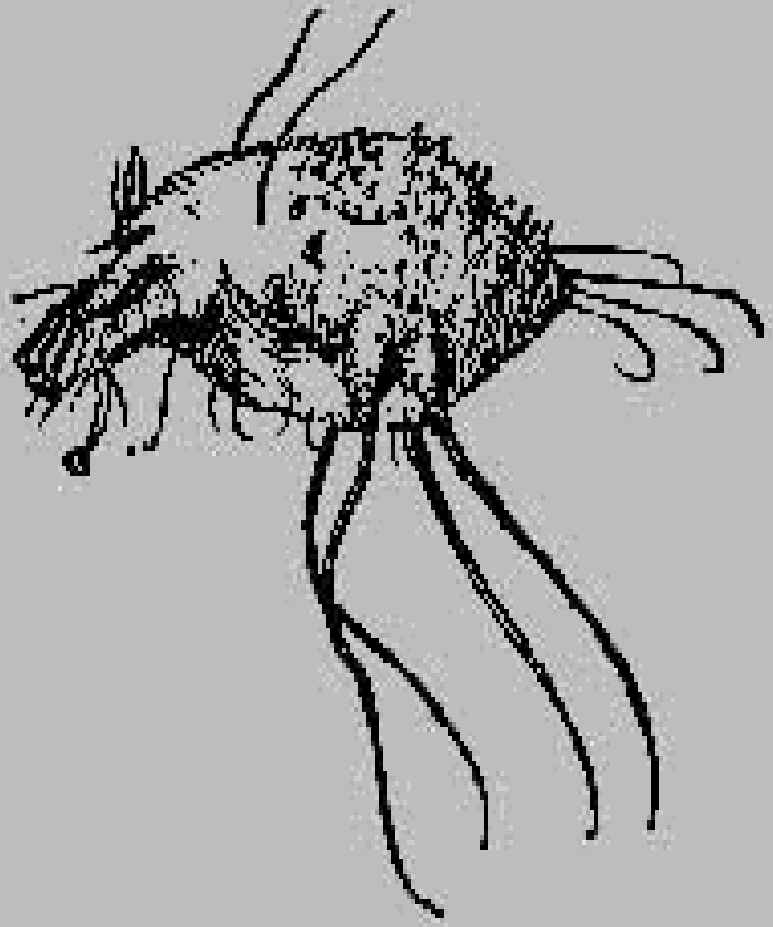
STRUCTURE OF A RETROVIRUS



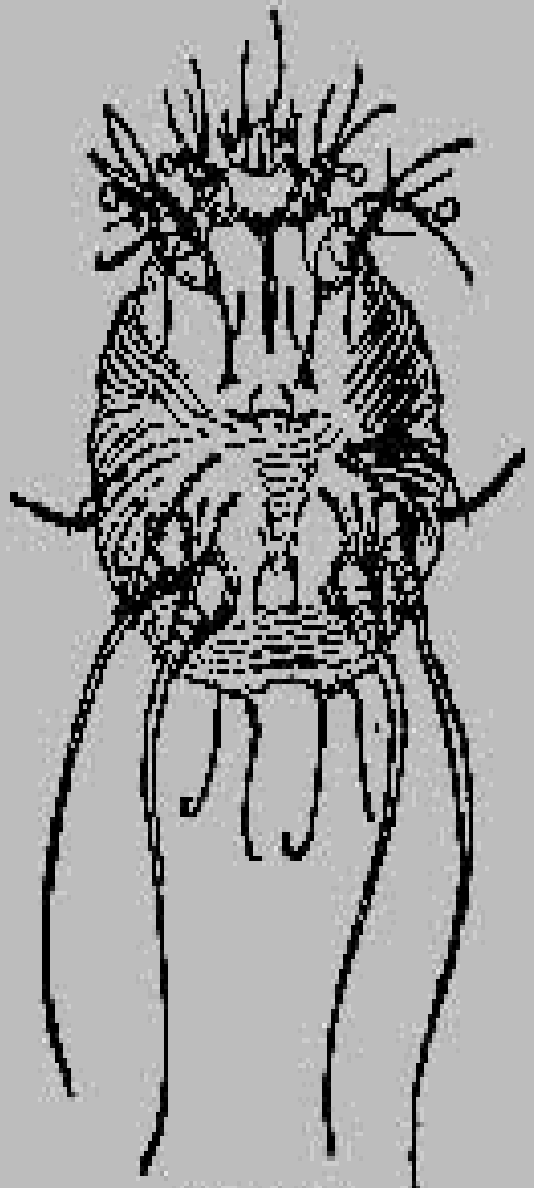
Helical structure of *Treponema pallidum* with the periplasmic flagella.



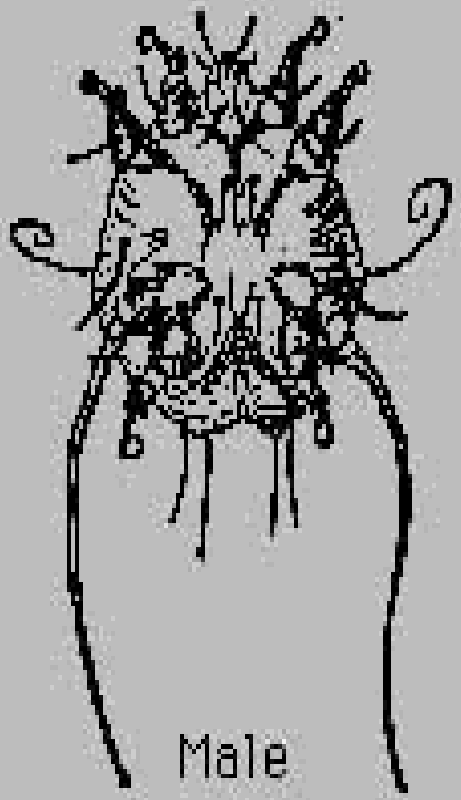
Sarcoptes scabiei



lateral



Female



Male

0.4 mm in length

Giemsa stain of blood with *Borellia burgdorferi*.

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

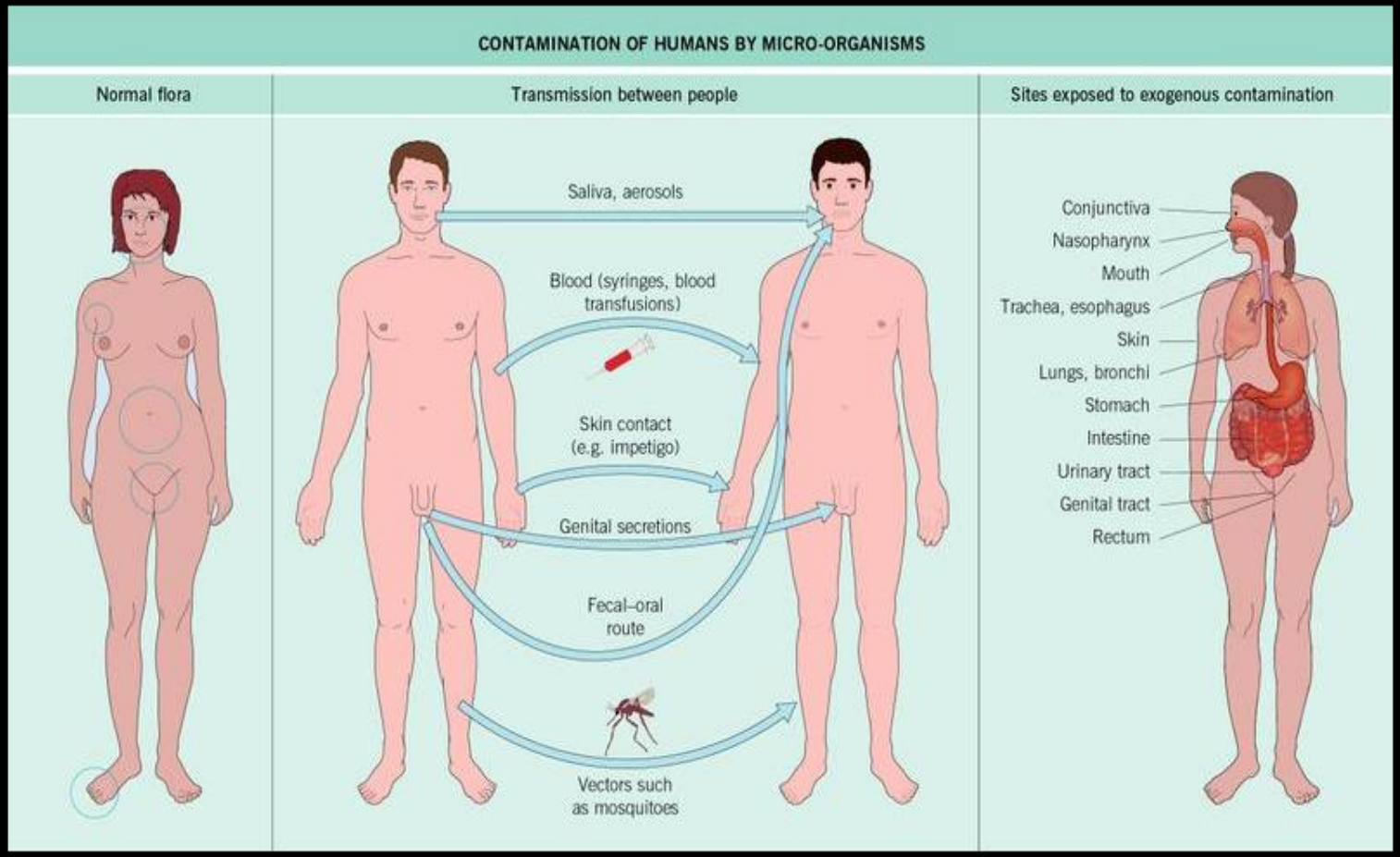
* heat, cold, dryness.

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.

Colonization 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

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 - 1. at the ende incubation period,
  2. if is ill,
  3. after acute stage –
  * reconvalescent,
  * carriers – healthy,
  * chronic diseases
- animals - at the same situation

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.

2. the metod of transmission

A/ direct contact

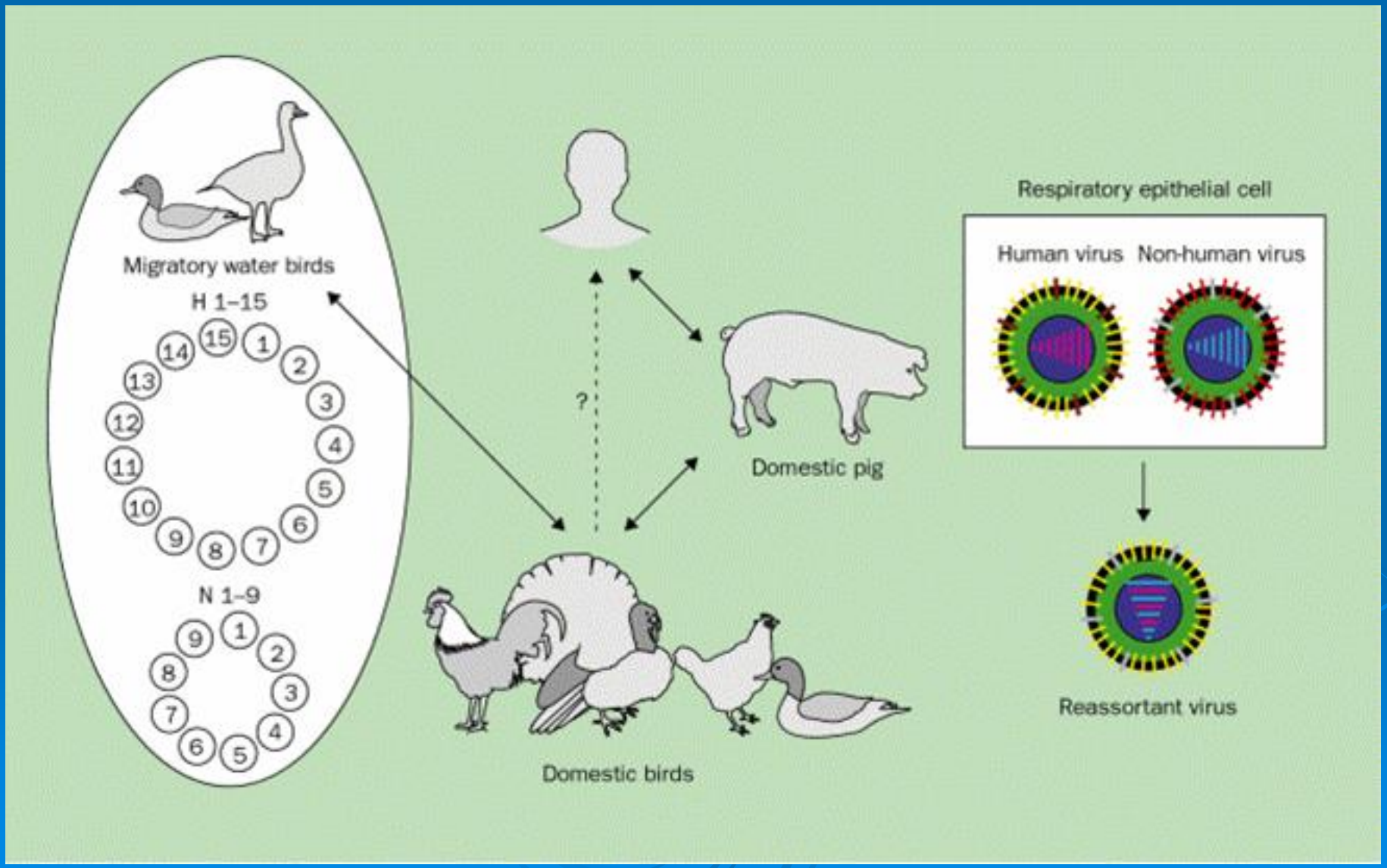
touching, kissing or sexual intercourse (Staphylococcus spp., Gonococcus spp.,HIV …),

- 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…)
- ingestion of food or water that is contaminated (salmonella, giardia, Norwalk virus, VHA….)
- biological transmission by insects (malaria, borellia….)

The rise of the pandemic strain



Interhuman transmission ?

Tick - Ixodes ricinus

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

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

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**

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- 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, specific),
- acquired (after vaccination)

THE INFECTION

= 1. source of infection

.....

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

ANTI - EPIDEMIC MEASURES

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

X ISOLATION

2. the way of **transmission**

X HAND WASHING, LINEN WASHING, CLEANING, GOOD PREPARING OF FOOD, SAFE WATER……., DISINFECTION, STERILIZATION

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

X VACCINATION

REDUCING THE INCIDENCE,
ELIMINATION,
ERADICATION

INFECTION
= 1. source of infection

- **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.

Remembering an Old Disease

Smallpox

Face lesions on boy with smallpox.

Public Health Images Library (PHIL) ID # 3.
Source: CDC/Cheryl Tyron

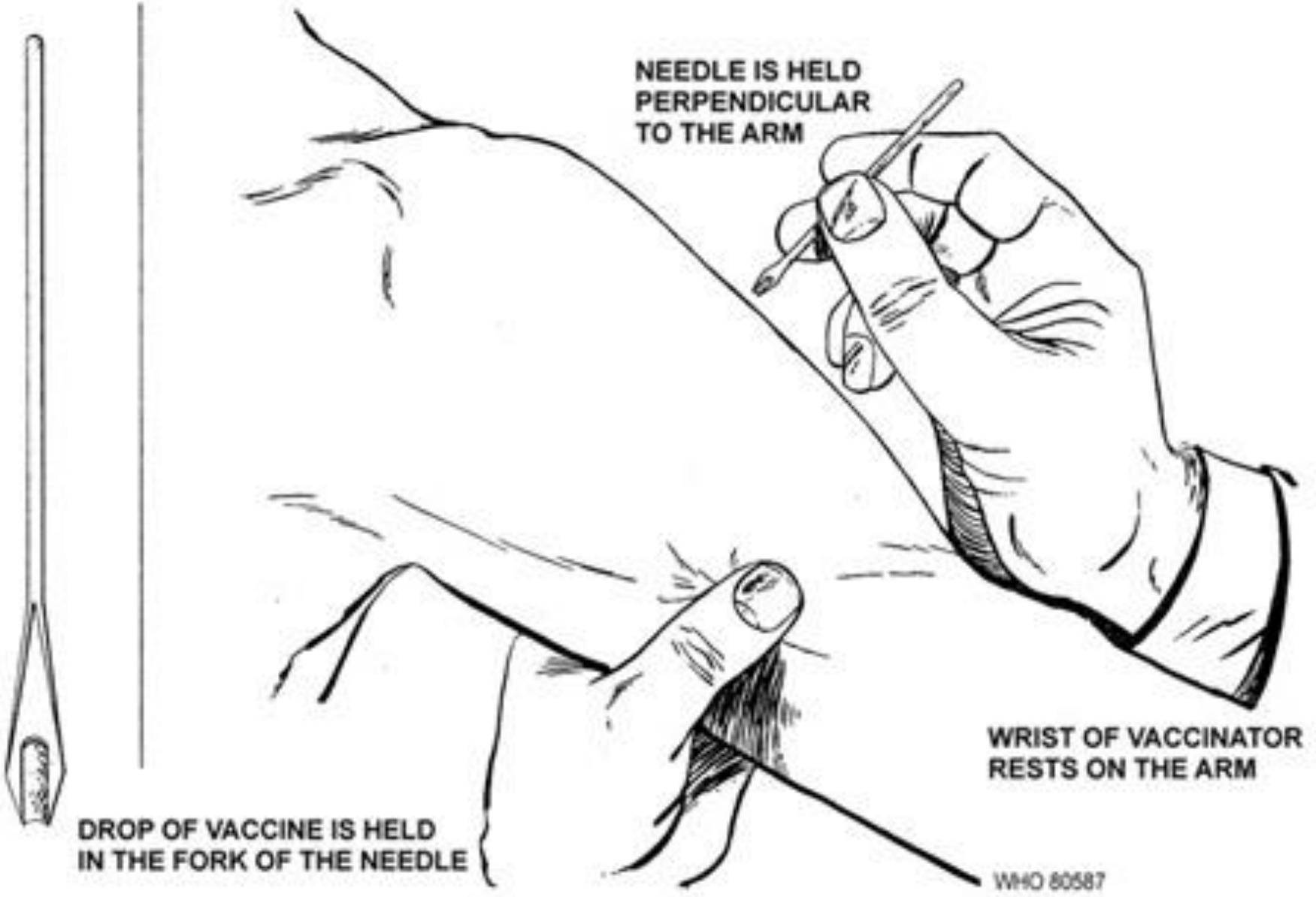
Smallpox recognition card, c.1973, courtesy Dr. Damodar Bhonsule, Panjim, Goa, India.

Smallpox lesions on skin of trunk.
Picture taken in Bangladesh, 1973.

Public Health Images Library (PHIL) ID # 284. Source: CDC/James Hicks

Rural vaccinator in United Provinces, British India, c.1930, private collection of Dr. Sanjoy Bhattacharya

MULTIPUNCTURE VACCINATION BY BIFURCATED NEEDLE



Variola virus, which causes smallpox, was once the scourge of the world.

This virus passes from person to person through the air.

A smallpox infection results in fever, severe aches and pains, scarring sores that cover the body, blindness in many cases, and, often, death. There is no effective treatment.

Although vaccination and outbreak control eliminated smallpox in the United States by 1949, the disease still struck an estimated 50 million people worldwide each year during the 1950s.

In 1967, the World Health Organization (WHO) launched a massive vaccination campaign to rid the world of smallpox —and succeeded.

The last natural case of smallpox occurred in Somalia in 1977.

Ali Maow Maalin, cook twenty-three of the hospitals in the Somali Merce.
He contracted when he showed the path of the ambulance chauffeur who drove two sick children to camp insulation.

In 1978 was ill photographer Medical School in Birmingham, England. She was killed by a virus that escaped from a neighboring lab.

Mr. John Wickett, of the World Health Organization, with the last person to have contracted – and survived – naturally occurring smallpox in Somalia.

(1977), courtesy Mr. John Wickett.

Eradication of smallpox
Czech experts

A key figure in the global eradication program smallpox was prof. MUDr. Karel Raska, MD., who drove in the sixties division

Communicative Diseases of the WHO

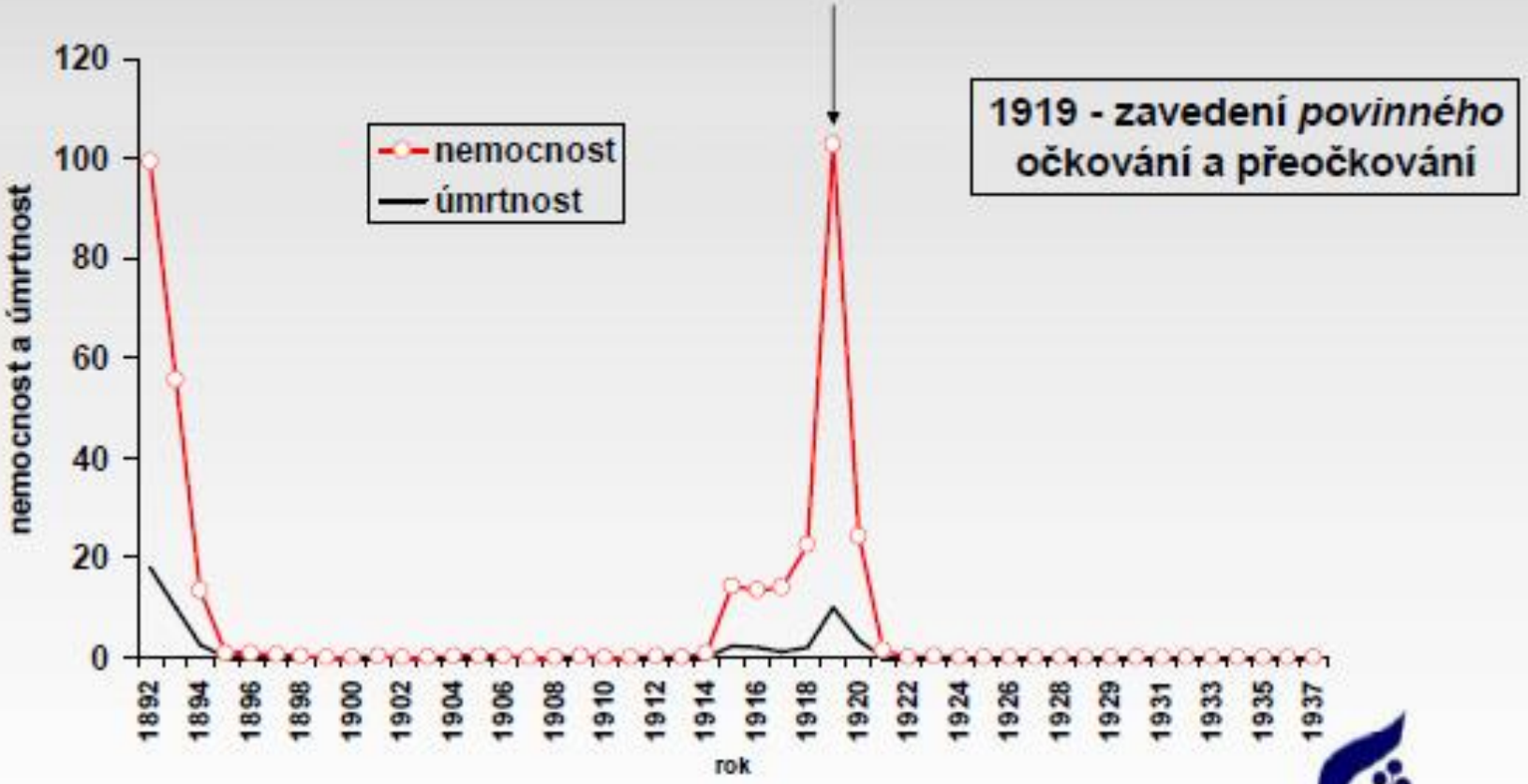
Secretariat in Geneva.

He promoted the establishment of a new, independent units "Eradication of smallpox"and ensure its initial financial and material support, not only in Geneva,
but also in regional offices of WHO.

With its support of the program also attended the 20 Czechoslovak health professionals (14 Czechs and Slovaks 6), mainly epidemiologists.

They participated in both the preparation methodology and procedures, thus working directly in infested areas.

Variola, České země, 1892-1937, nemocnost a úmrtnost na 100 000 obyvatel



Státní zdravotní ústav

SZÚ

Smallpox eradication was
officially announced
at the 33rd General Assembly WHO

8. May 1980.

Tuesday, March 8, 2011; 9:41 AM

Milestones in the eradication of smallpox

1789 Edward Jenner invents a smallpox vaccine.

1966 The World Health Organization (WHO) launches a massive global campaign to eradicate smallpox.

1972 Smallpox vaccinations are discontinued in the United States.

1975 and 1977 The last cases of the two known variants of smallpox occur in the world, in Bangladesh and Somalia.

1978 Two people are sickened in a lab accident in England; one dies.

1980 The WHO declares smallpox eradicated.

1991 Smallpox virus DNA is mapped.

1999 The WHO sets this deadline, by which remaining lab stocks of the virus are to be destroyed. The deadline will be postponed again and again.

2003 Millions of doses of vaccine are produced to hedge against a biological attack.

2011 WHO's decision-making body will meet in May to again vote on whether to kill the remaining live viruses.

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.

Epidemiology of communicable diseases (ECDC)

Infection prevention and control in dentistry

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