

**Institute for Microbiology, Medical Faculty of Masaryk University  
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# **Agents of bloodstream infections**

# Bloodstream infections

- **less common than respiratory or urinary tract infections, but severe and lifethreatening**
- **Types of bloodstream infections:**
  - 1) **Infection of the complete bloodstream = sepsis**
  - 2) **Infection of a part of bloodstream (endocarditis, tromboflebitis), leads to sepsis**

**Bacteremia = mere presence of bacteria in blood.**

**Bacteria (at least in higher amounts) = starting mechanism of sepsis**

**Interaction of microbial products with macrophages releases a lot of cytokines**

- **systemic inflammatory response syndrome (SIRS) characterized by:**
- **elevated temperature**
  - **accelerated pulse and breathing**
  - **leukocytosis**

# Sepsis

**Sepsis = suspect or proved infection + systemic inflammatory response syndrome**

**Severe sepsis = sepsis + organ dysfunction  
(hypotension, hypoxemia, oliguria, metabolic acidosis, thrombocytopenia, confusion, DIC)**

**Septic shock = severe sepsis + hypotension despite adequate supply of fluids**

# Sepsis cascade

## Invasive Infection

(Foreign antigens from cell walls of bacteria and fungi, bacterial DNA, RNA from viruses, etc.)

## Body's Immune Cells

(Macrophages, neutrophils, endothelial cells, monocytes)

## Cytokine Release

(Interleukins, interferons, tumor necrosis factor, etc.)

*Damage to blood vessel linings*

**Inflammation** ↑

(Vasodilation, capillary leak)

**Coagulation** ↑

**Fibrinolysis** ↓

## Severe Sepsis / Septic Shock

## Multiple Organ Dysfunction Syndrome

*Lung, Liver, Kidney*

## Death

(Mortality 40 - 60% in severe sepsis/septic shock)



# Features of sepsis

## Clinical:

fever or hypothermia (often changing)

↑↓ T

tachycardia

↑↑ P

tachypnoe

↑ B

lowered blood pressure

↓ BP

confusion

## Pathophysiological:

higher heart output

lower peripheral vascular resistance

## Laboratory:

leucocytes

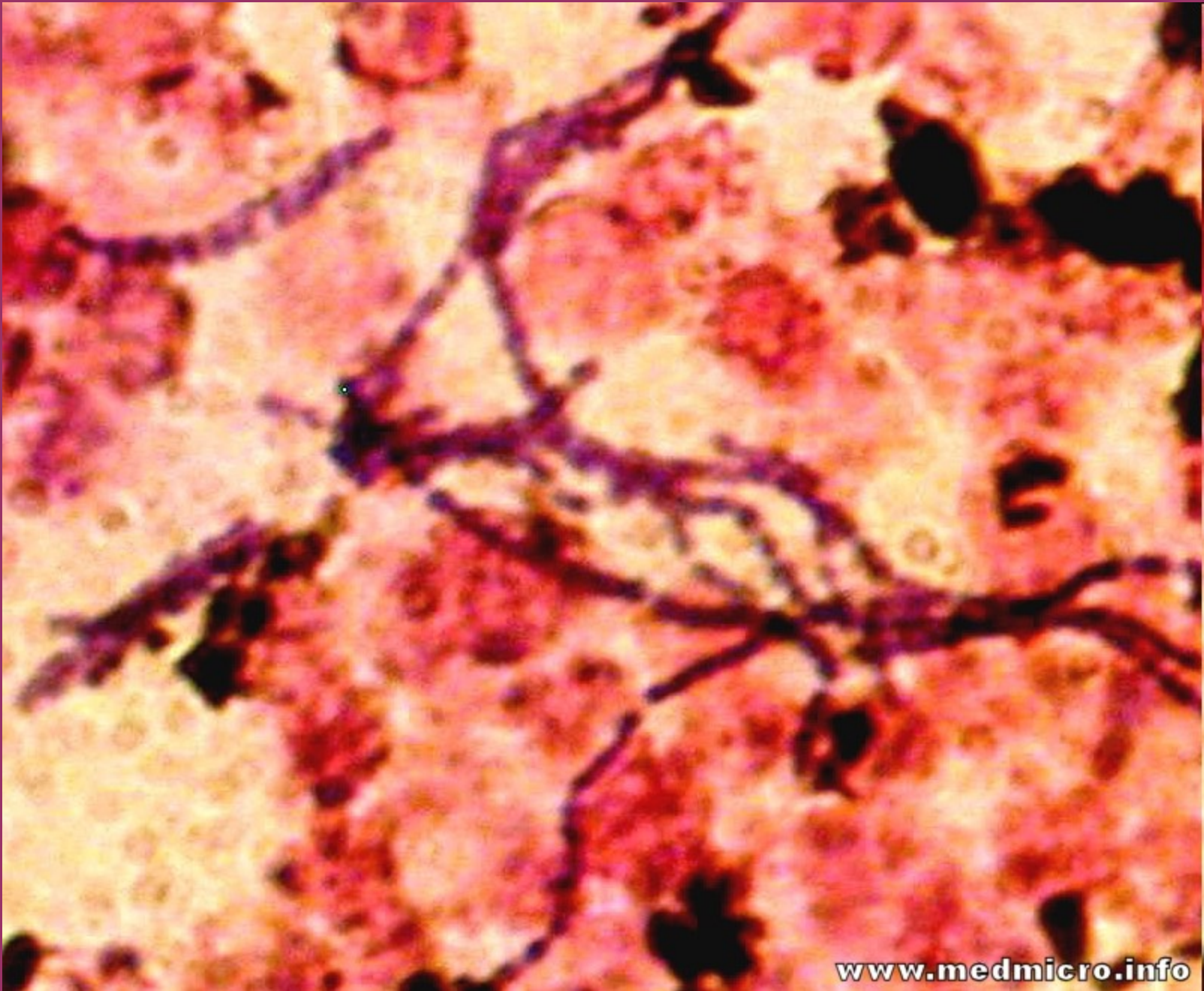
↑↓ Leu

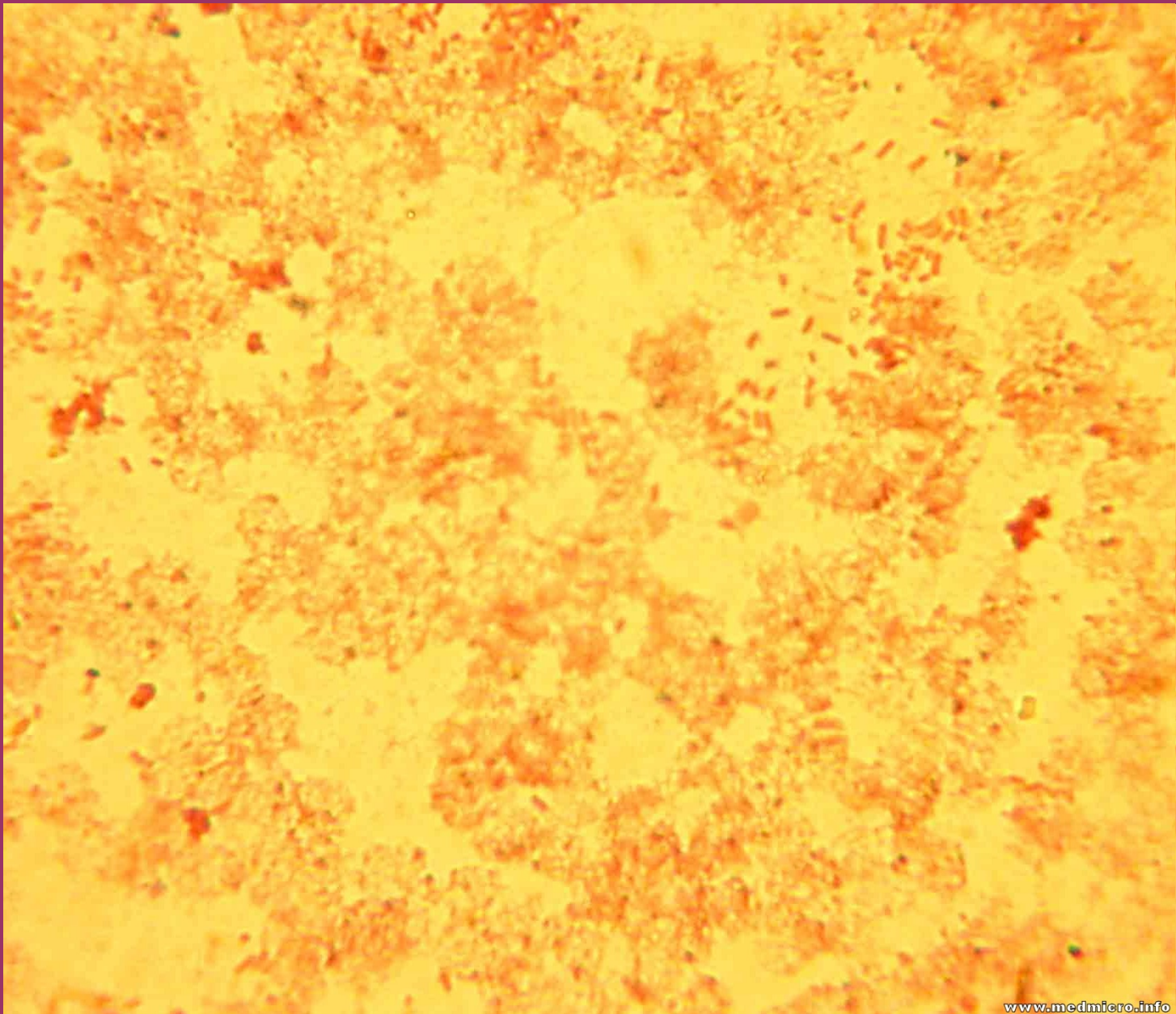
serum bicarbonate

↓  $\text{HCO}_3^-$

bacteremia

may not be already demonstrable







# Types of bacteremia – I

## Intermittent – in localized infections

**pneumonia** (for example pneumococci)

**meningitis** (for example meningococci)

**pyelonephritis** (*Escherichia coli*)

**osteomyelitis** (*Staphylococcus aureus*)

**septic arthritis** (*S. aureus*, gonococci)

# Types of bacteremia – II

## Continual – in generalized infections

**typhoid fever** (*Salmonella Typhi*)

**brucellosis** (*Brucella melitensis*)

**plague** (*Yersinia pestis*)

# Types of bacteremia – III

## Bacteremia in bloodstream infections

**thrombophlebitis** (*S. aureus*, *S. pyogenes*)

**acute endocarditis** (*S. aureus*, *S. pyogenes*, *S. pneumoniae*,  
*Neisseria gonorrhoeae*)

**subacute bacterial endocarditis = sepsis lenta**

(viridans streptococci, enterococci,

HACEK group =

*Haemophilus aphrophilus*

*Actinobacillus actinomycetemcomitans*

*Cardiobacterium hominis*

*Eikenella corrodens*

*Kingella kingae*)

**„culture-negative“ endocarditis** (*bartonellae*, *coxiellae*,  
*legionellae*)

# Types of bacteremia – IV

## Special circumstances

**Bacteremia in some malignities** (colonic Ca – Streptococcus bovis, leukemia - various bacteria)

**Bacteremia in intravenous drug users** ( skin flora – staphylococci, corynebacteria; mouth flora and bacteria from the environment)

**!!Bacteremia in iatrogenic infections**  
(e. g. mouth flora after tooth extraction, pharyngeal flora after bronchoscopy etc.)



# Types of bacteremia – V

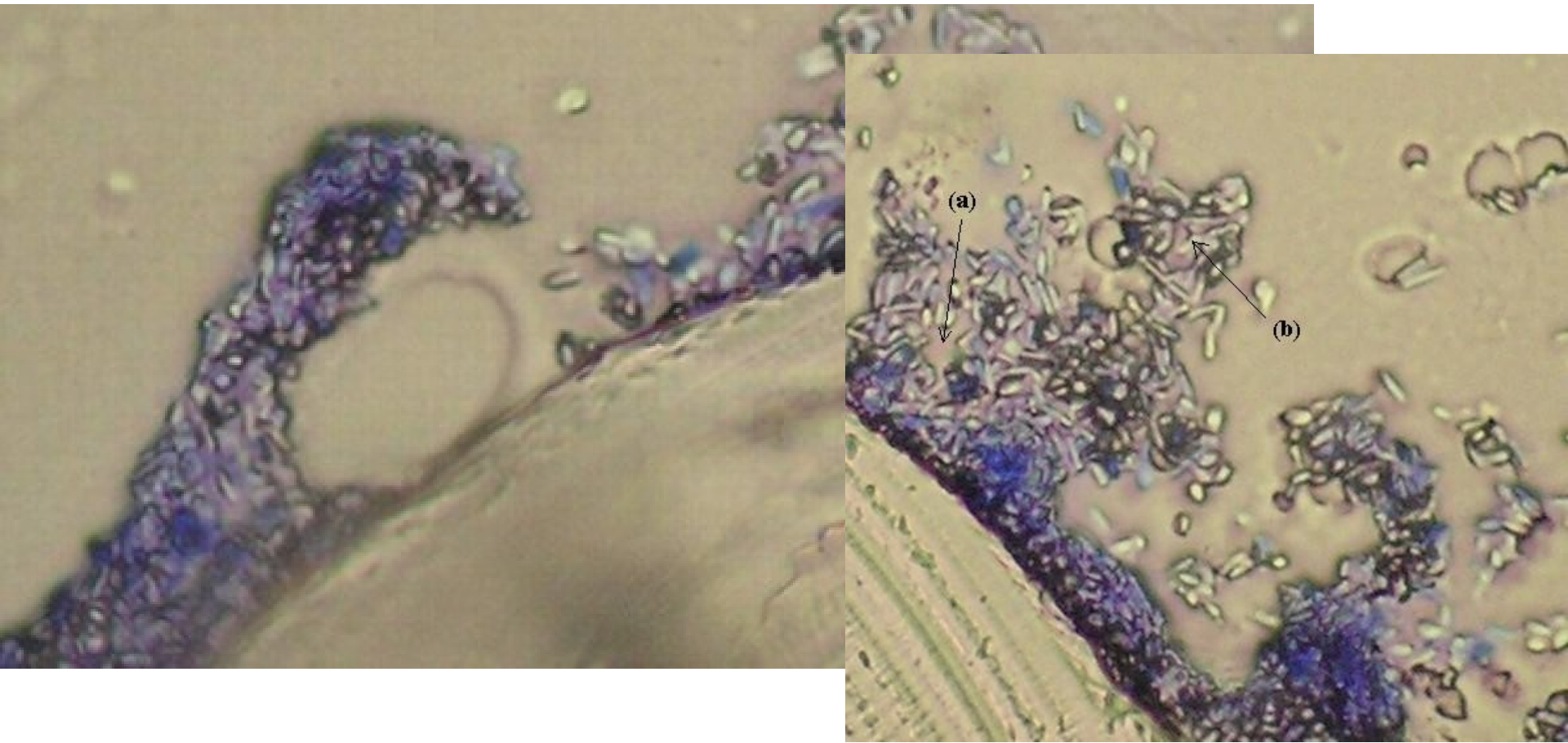
## Bacteremia related to artificial material

**Vascular catheters, invasive devices and implants, endoprotheses etc. (biofilm)**

**ICU, immunocompromised, febrile neutropenia**

**Coagulase-neg. staphylococci, *S.aureus*, enterococci, corynebacteria, yeasts etc.**

**True bacteremia vs contaminants!**



**Biofilm on a catheter (stafylococci and candidae):**

**a) - canaliculus, b) - porous structure**

Photo: Dr. Veronika Holá, MÚ

# Sepsis according to the origin

- **Wound sepsis** (*Staphylococcus aureus*, *Streptococcus pyogenes* and other beta-hemolytic streptococci, *Pseudomonas aeruginosa* in burns)
- **Urosepsis** (*Escherichia coli*, *Proteus mirabilis* and other enteric bacteria)
- **Abdominal** sepsis (often polymicrobial etiology, anaerobes (*Bacteroides* etc.) and facultative anaerobes (*Escherichia coli*))

# Fulminant sepsis

... a quick course; when it is not diagnosed in time, it often kills the patients

Clonal strains of *Neisseria meningitidis*  
(sepsis with or without meningitis)

*Streptococcus pyogenes* (often together  
with necrotizing fasciitis)

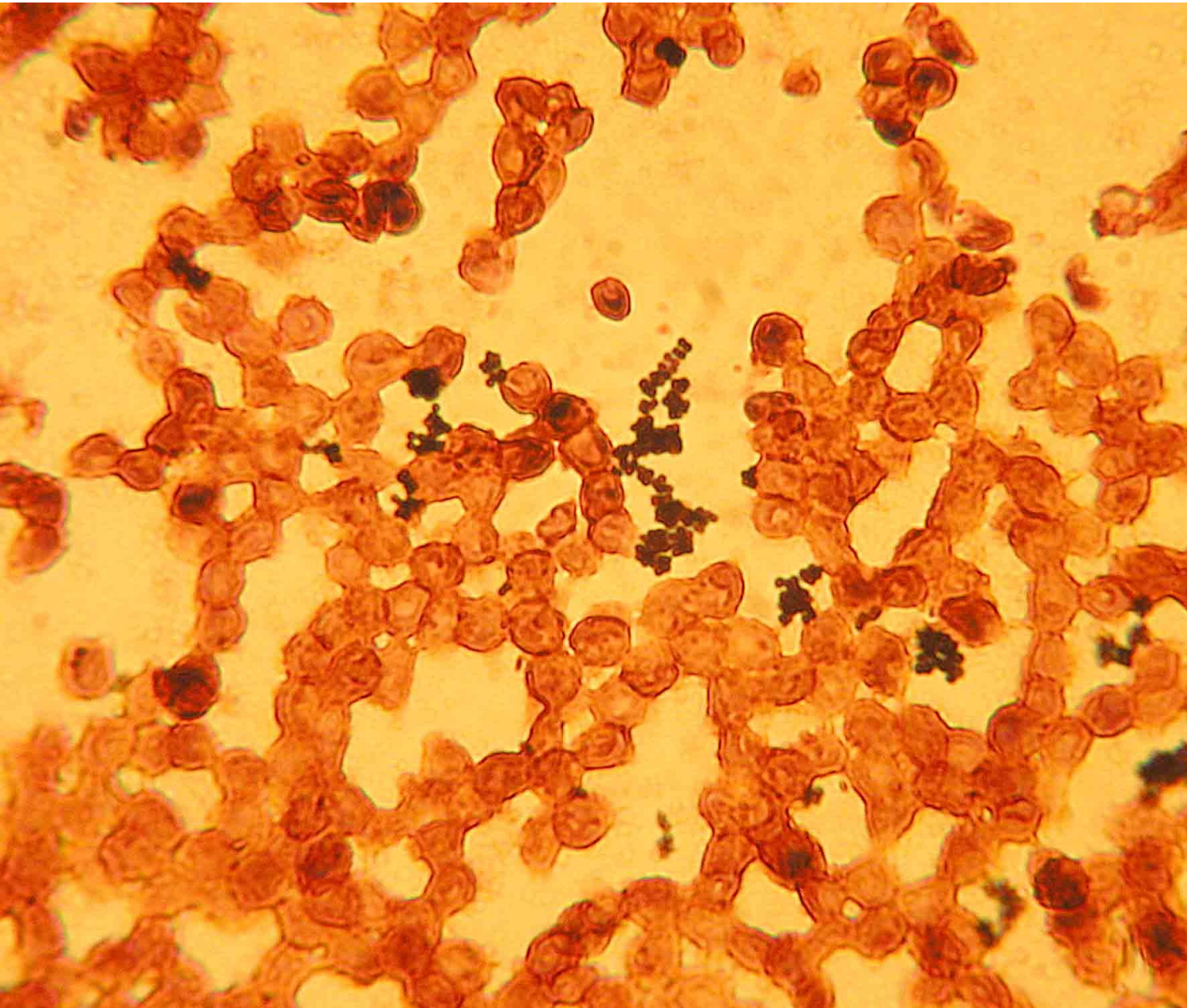
*Yersinia pestis*



# Nosocomial sepsis

- **Staphylococci, coagulase-negative**  
(intravenous catheter-associated sepsis, infections of plastic devices *in situ*, febrile neutropenia)
- ***Staphylococcus aureus*** (infected surgical wounds)
- ***E. coli* + other enterobacteria** (catheter-associated infections of the urinary tract)
- **Gram-negative non-fermenting rods**  
(contaminated infusion fluids)
- **yeasts** (catheter-associated sepsis, febrile neutropenia)
- **Enterococci** and many other microbes

# Staphylococci in blood culture



# Diagnosics of sepsis

- **Blood cultures** (not clotted blood; ≠ blood for serological examination!)
  - special vessels, automated culture
  - two, but better 3 blood cultures
  - At least one blood culture should be taken from venepunction (i. e. not only central venous catheter)
- **parts of blood catheters**

# Contaminants

- **Inproper sampling, insufficient disinfection**
- **Sampling from catheters only and not venepunction** (the bacterium colonizing the venous catheter is not necessarily a real bloodstream pathogen)
- **Coagulase-negative staphylococci**

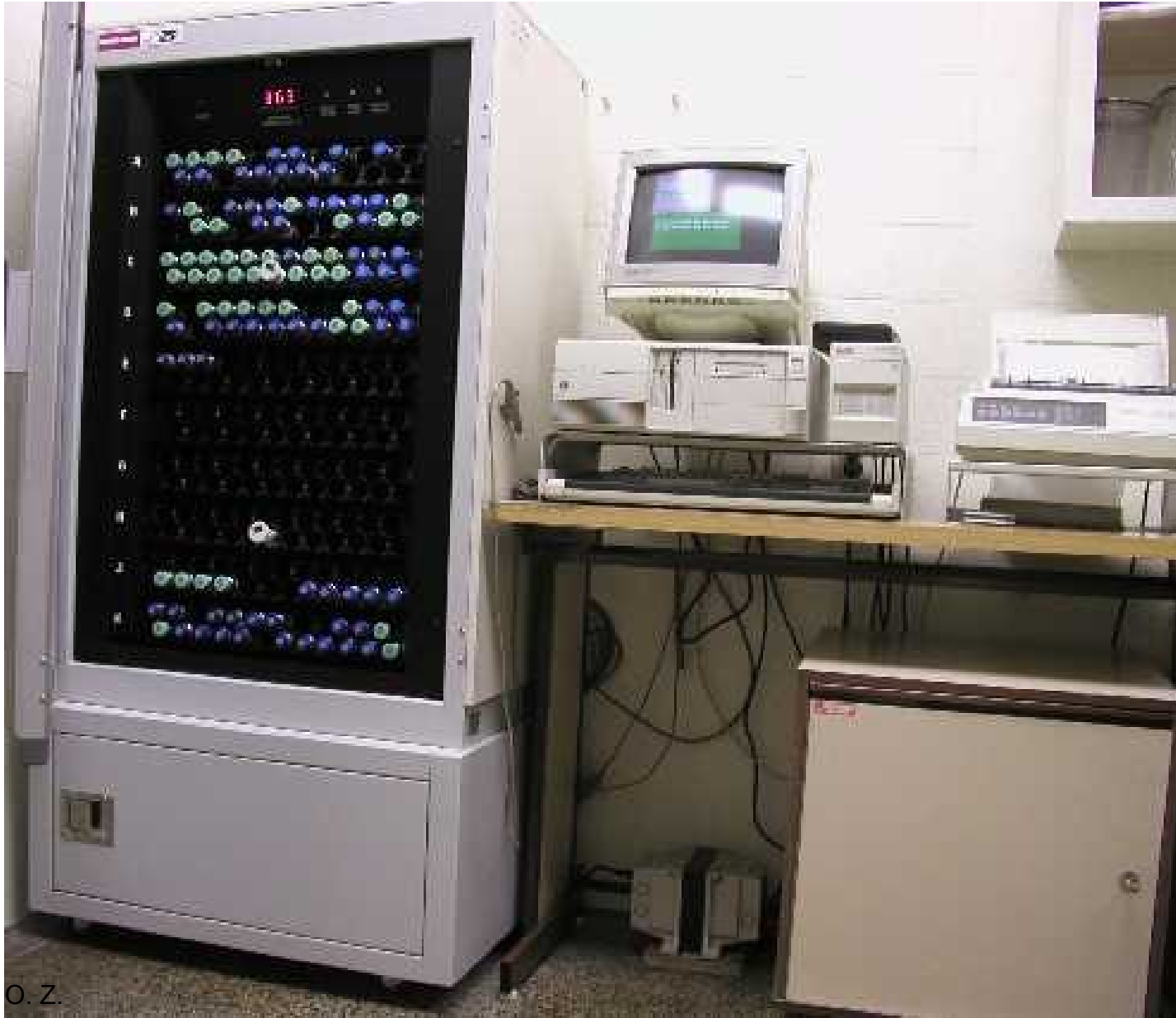
# Examples of blood culture vessels



# Blood culture device



# The same device open



# Treatment of sepsis

## ICU

- **antibiotics – empiric therapy in the beginning, targeted therapy later**
- **removal of all infected tissues or devices**
- **support of breathing and hemodynamics (artificial ventilation, oxygen, fluids, vasopressors etc.)**



**Michael Sweerts  
(1618-1664):  
Plague in an Ancient  
City**

