

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

Bloodstream infections

- Bloodstream infections are not so common as e. g. respiratory or urinary tract infections, but they used to be **severe and threatening the patient's life**
- **Types of bloodstream infections:**
 - Infection of the complete bloodstream = **sepsis**
 - Infection of a part of bloodstream (endocarditis, thrombophlebitis); usually leads to sepsis

Bacteremia = mere presence of bacteria in blood. Nevertheless:

Bacteria (at least higher amounts of them) = 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 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)



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

Features of sepsis

Clinical:

fever or hypothermia (often changing)
tachycardia
tachypnoe
lowered blood pressure
confusion

↑↓ T
↑ P
↑ B
↓ BP

Pathophysiological:

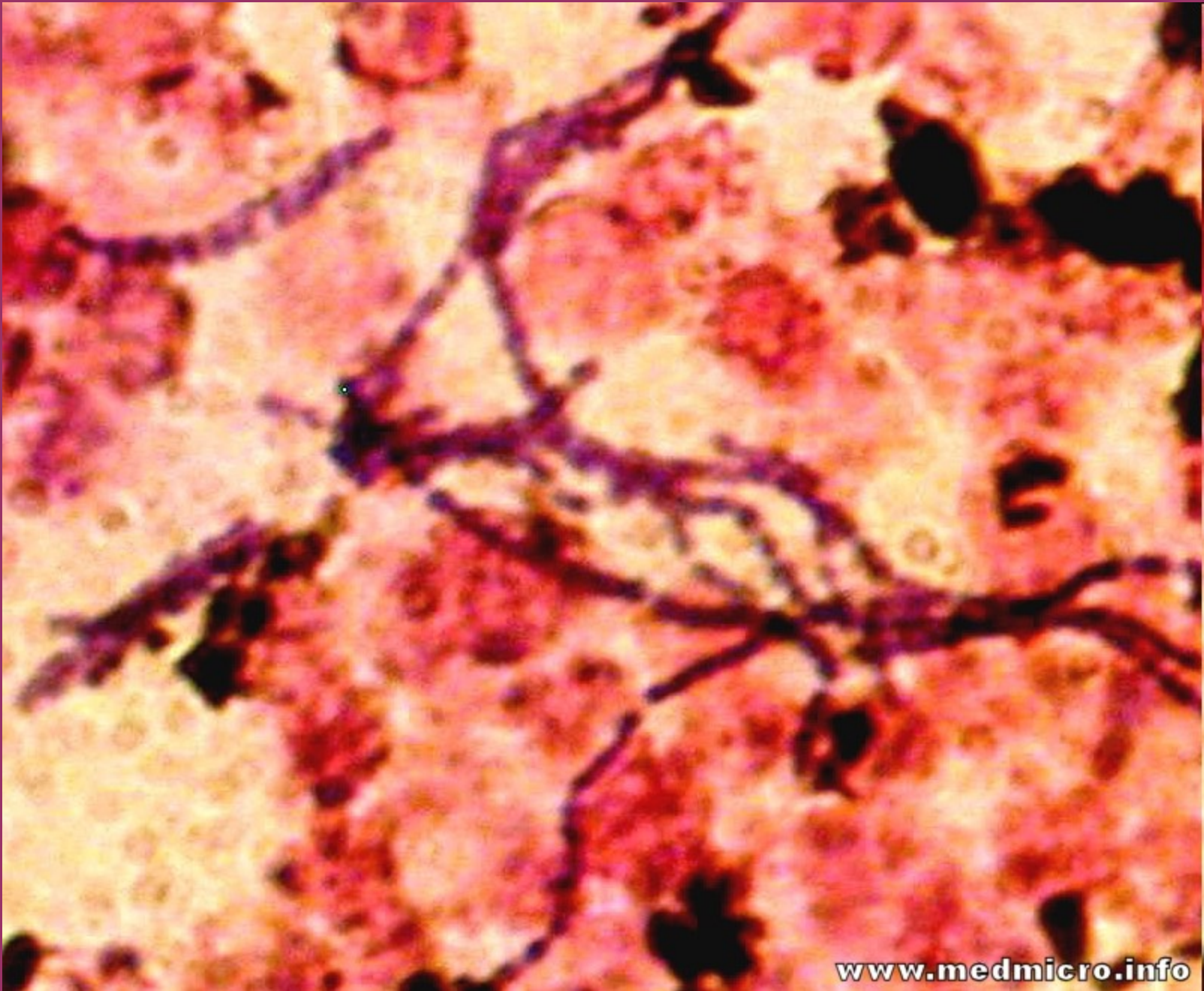
higher heart output
lower peripheral vascular resistance

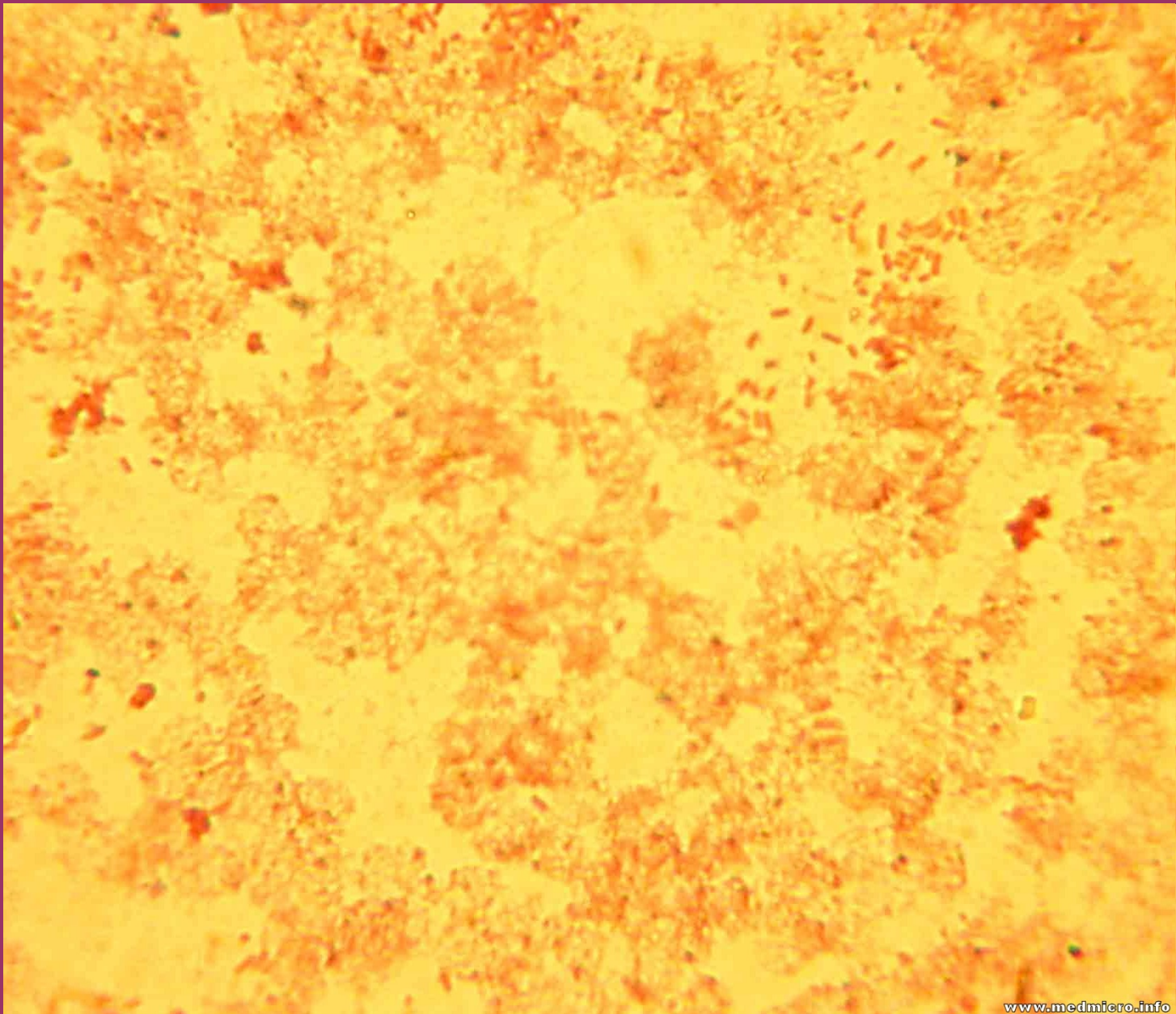
Laboratory:

leucocytes
serum bicarbonate
bacteremia

↑↓ Leu
↓ HCO₃⁻

may not be already demonstrable





Types of bacteremia – I

Intermittent bacteremia – in localized infections

pneumonia (for example pneumococci)

meningitis (for example meningococci)

pyelonephritis (*Escherichia coli*)

osteomyelitis (*Staphylococcus aureus*)

septic arthritis (*S. aureus*, gonococci)

and others

Types of bacteremia – II

Continual bacteremia – in generalized infections

typhoid fever (*Salmonella Typhi*)

brucellosis (*Brucella melitensis*)

plague (*Yersinia pestis*)

Pathogens, causing primary, continual bacteremia, are quite rare today.

But under some circumstances, also pathogens from „group I“ may perform a continual bacteremia, or rather sepsis

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 (*Bartonella*, *Coxiella*,
Legionella)

Types of bacteremia – IV

Special circumstances

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

Bacteremia in intravenous drug users (mostly skin flora – staphylococci, corynebacteria; sometimes also 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

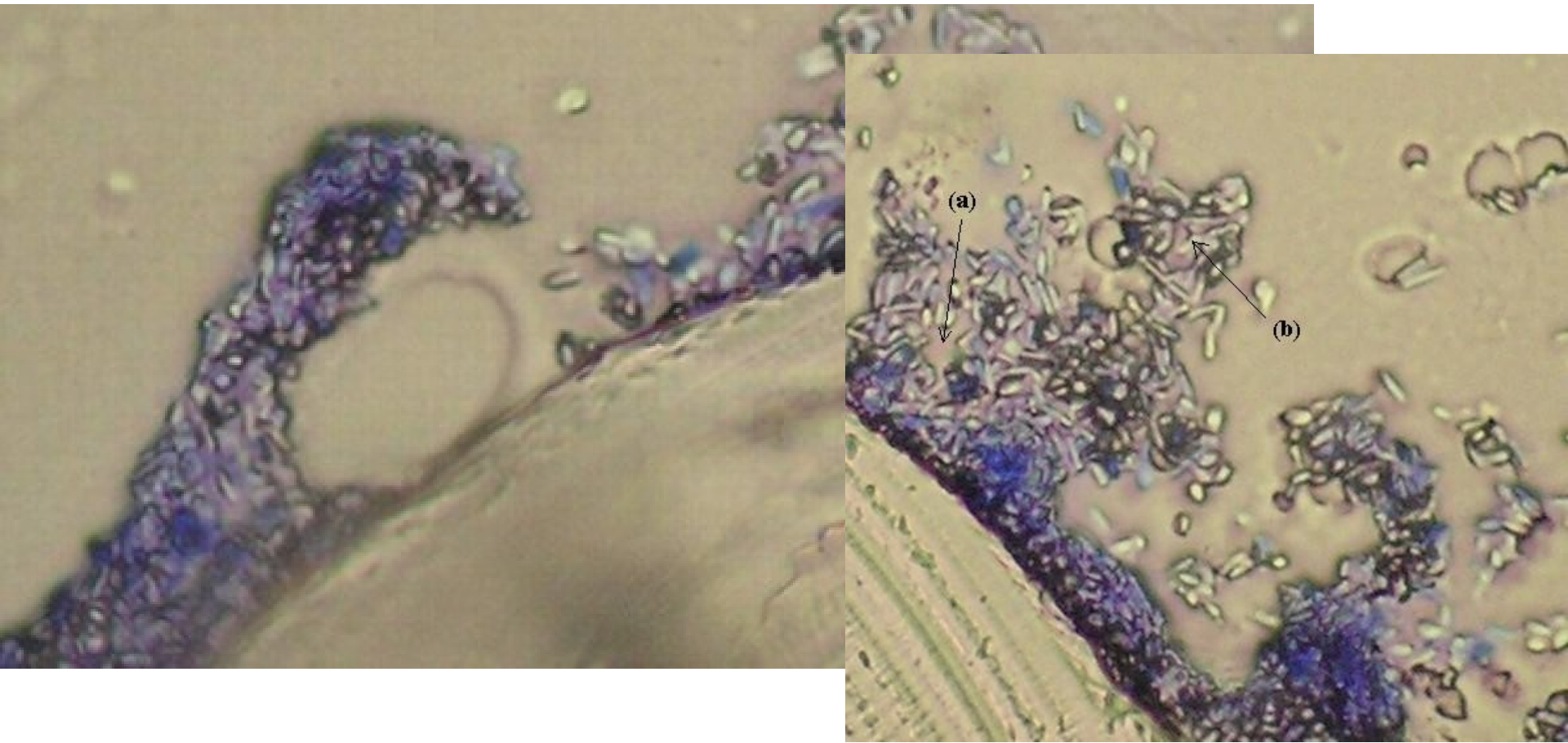
Bacteremia related to artificial material

Typically on **vascular catheters**, invasive devices and implants, endoprotheses etc. (biofilm)

More common in emergency units, immunocompromised, febrile neutropenia

Caused by coagulase-negative staphylococci, *S. aureus*, enterococci, corynebacteria, yeasts etc.

As the majority of them are normal flora of skin, it is extremely difficult to differentiate bacteremia from pseudobacteremia here!



Biofilm on a catheter (stafylococci and candidae):

a) - canalculus, b) - porous structure

Photo: Dr. Veronika Holá, MÚ

Sepsis caused by yeasts is very dangerous, especially because the initial treatment by antibiotics is not effective.

Candida

Sepsis according to the origin

- sepsis from **wounds** (*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

Fulminant sepsis is a sepsis with 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 of muscle fasciae)

Yersinia pestis

Nosocomial sepsis

Often related with artificial materials

Staphylococci, coagulase-negative (intravenous catheter-associated sepsis, infections of plastic devices *in situ*, febrile neutropenia)

Staphylococcus aureus (infected surgical wounds)

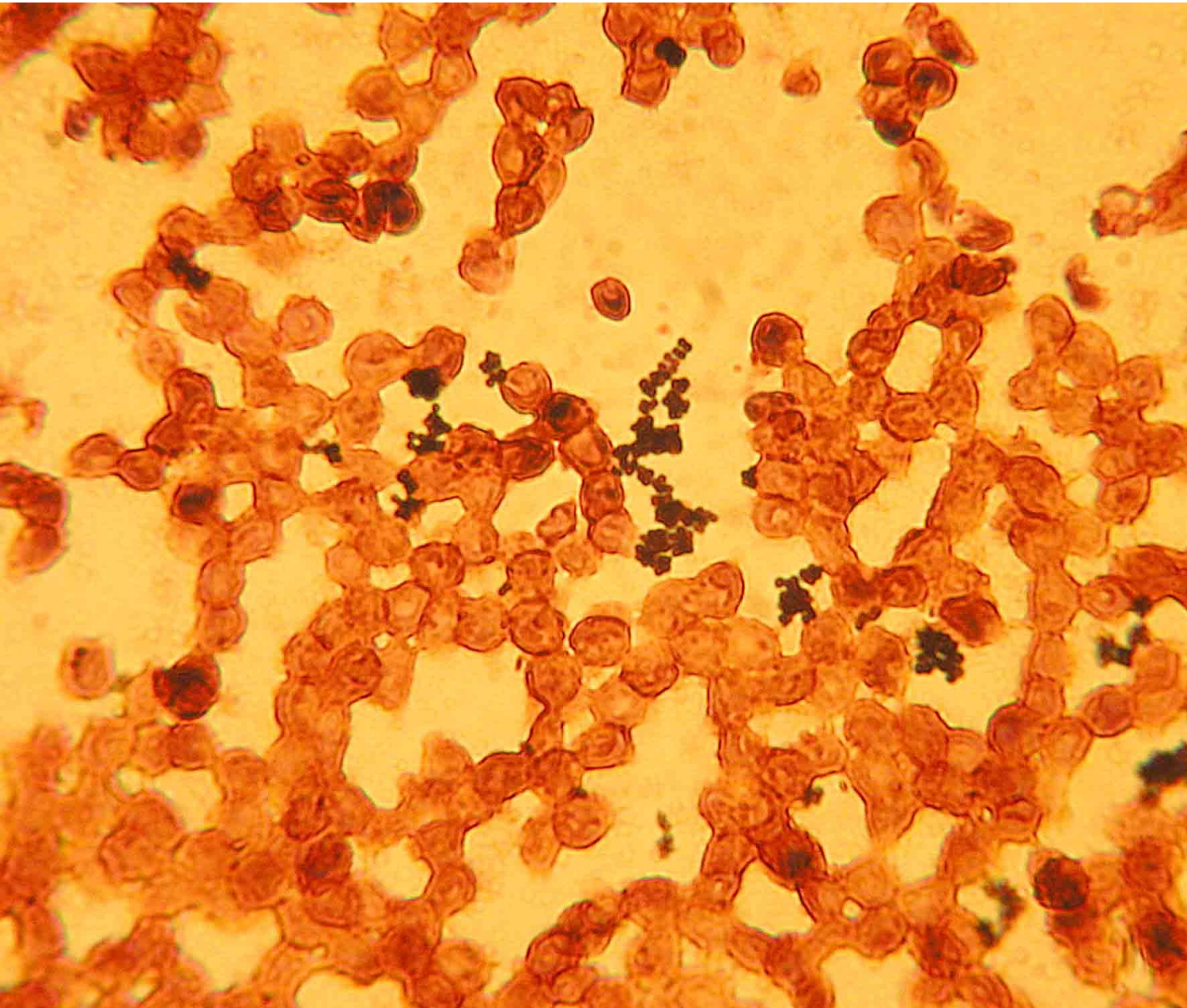
***E. coli* + other enterobacteria** (catheter-associated infections of the urinary tract)

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!)
 - Today mostly in special vessels for automated culture
 - At least two, but better two blood cultures, usually at the temperature increase
 - At least one blood culture should be taken from a new venepuncture (i. e. not only central venous catheter)
- **parts of blood catheters**

Blood sampling

- **Aseptically!** Not only because of the patient, but also because of the sample. Skin cleaning is not sufficient, disinfection is necessary
- **The disinfectant should be let to act enough** (in alcohol disinfectants it is necessary to let them dry)
- **Mostly use three identical type vessels**, eventually one for anaerobic culture (especially in suspicion for abdominal origin of sepsis)
- It is necessary to **fill in the order form carefully**, to add the time of material taking

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



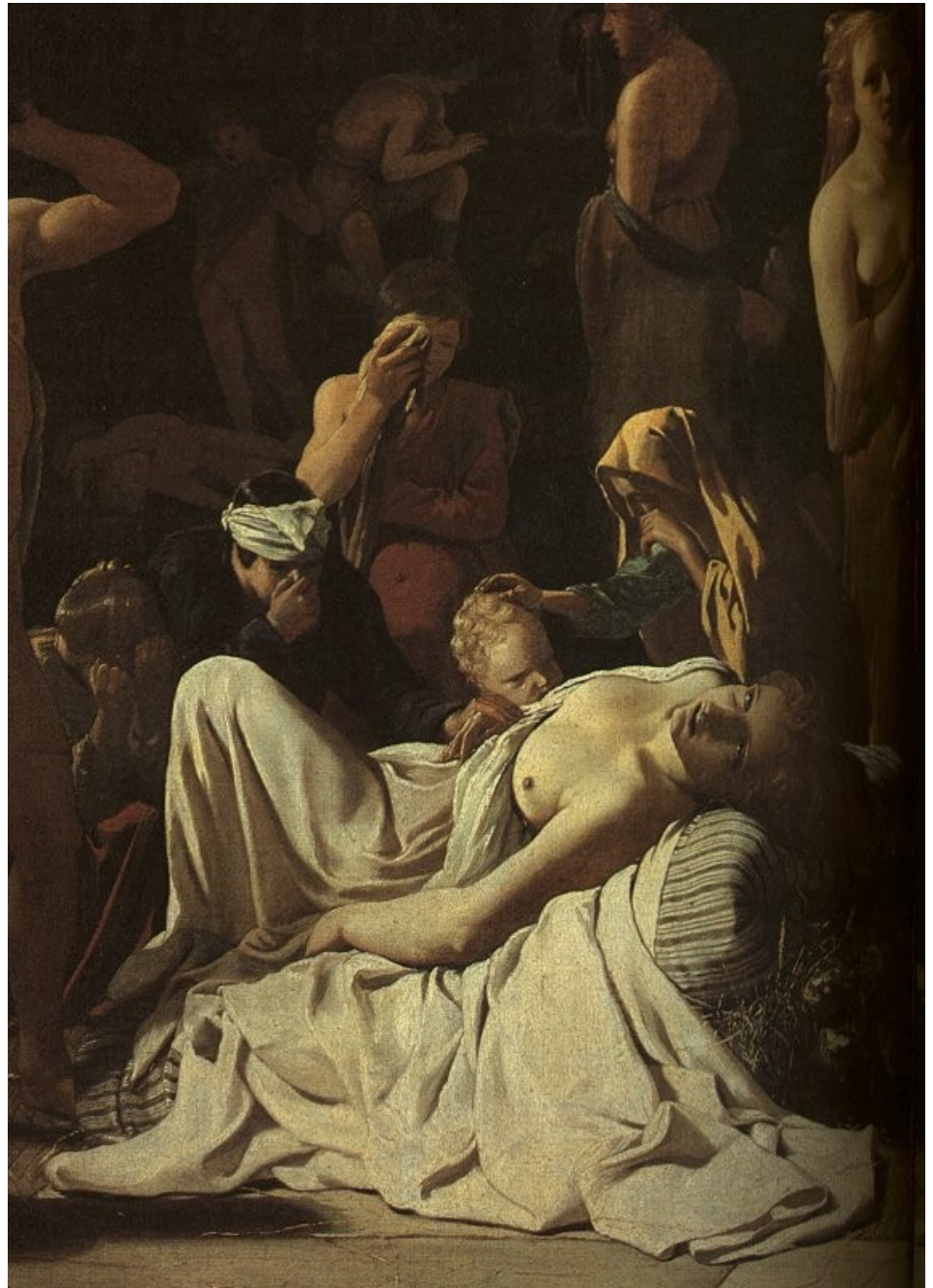
Treatment of sepsis

At intensive care units only

- **antibiotics – usually 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.)**

Homework 8 – solution

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



Homework 9

