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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

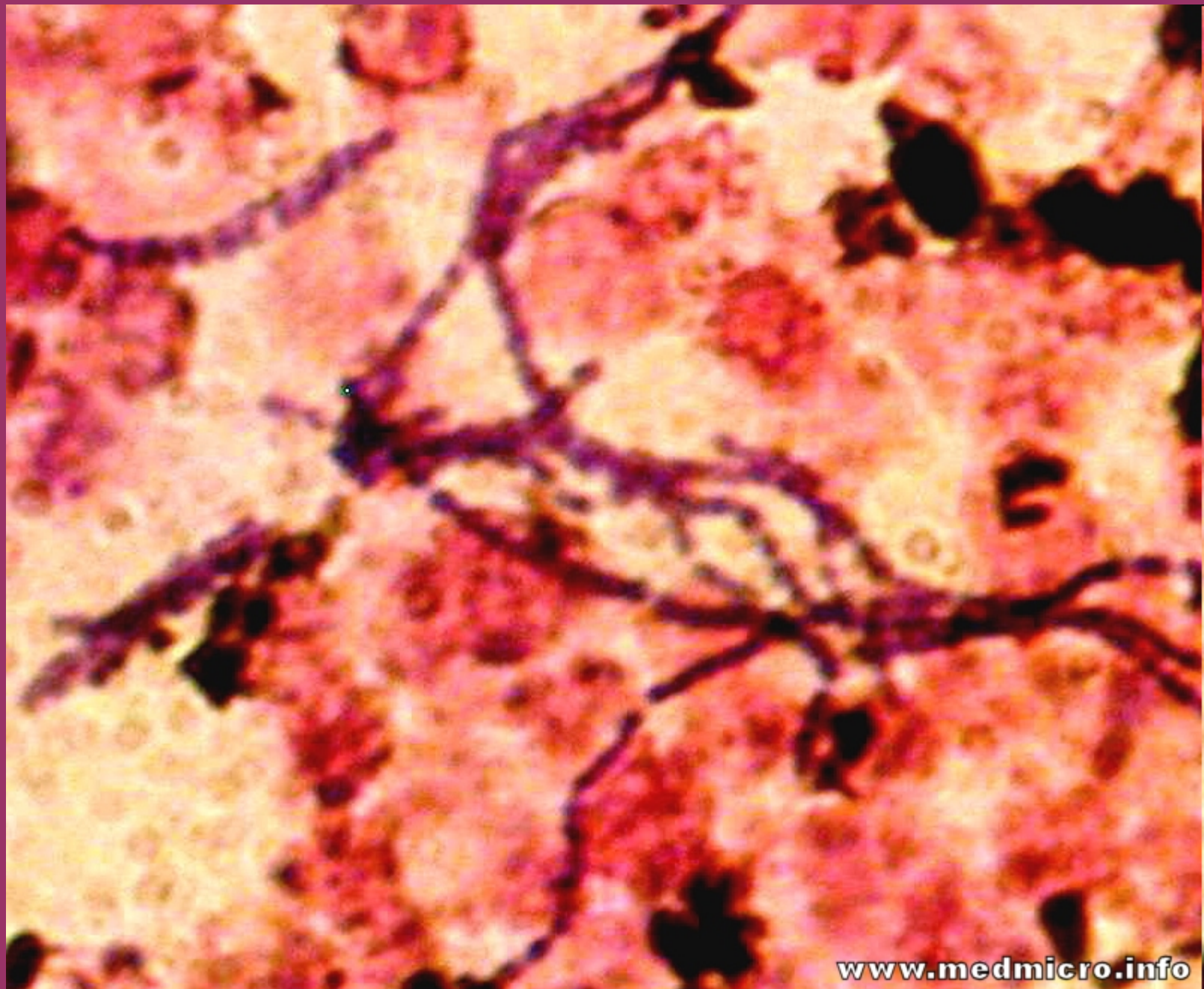
↑↓ Leu

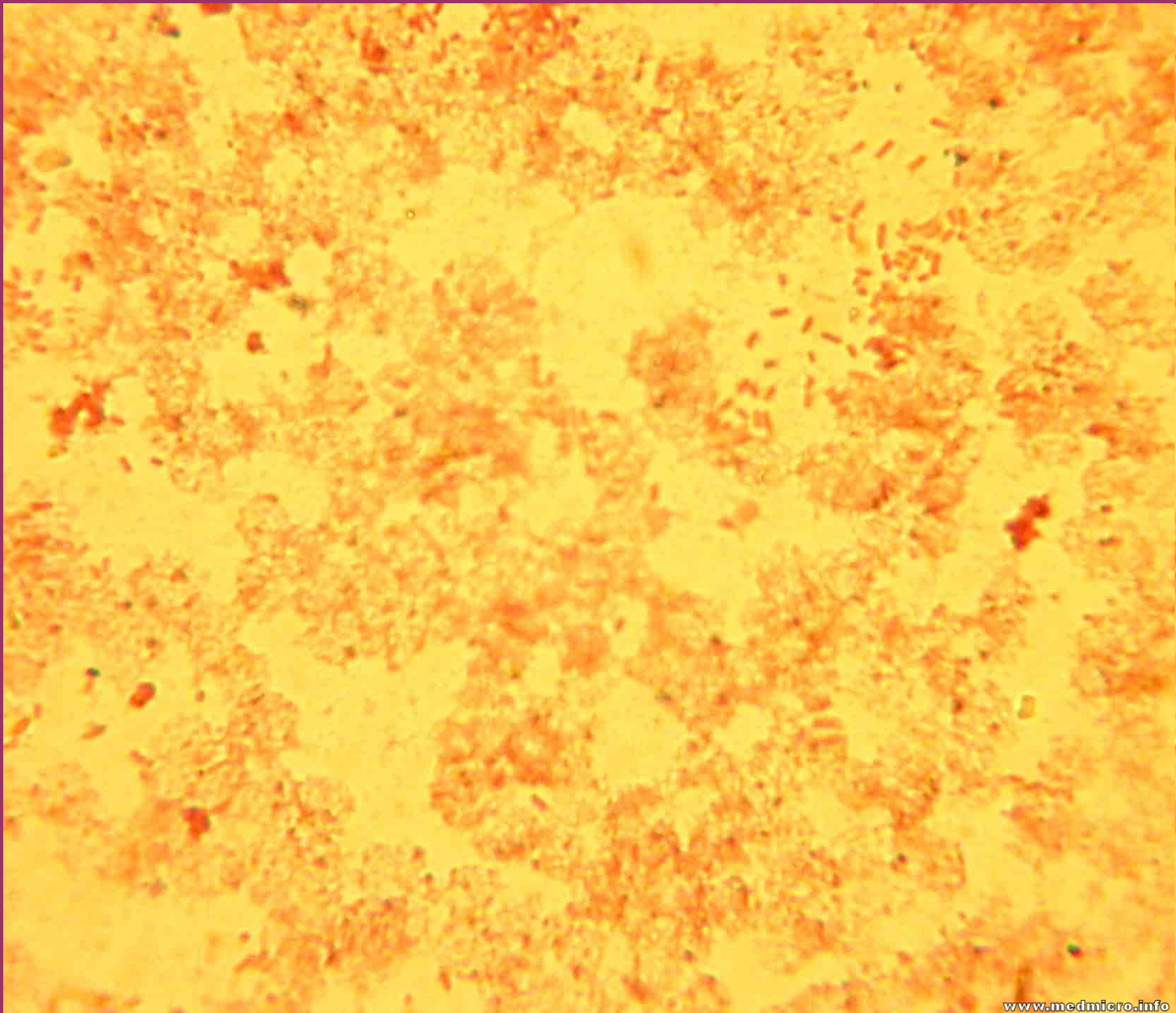
serum bicarbonate

↓ HCO₃⁻

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

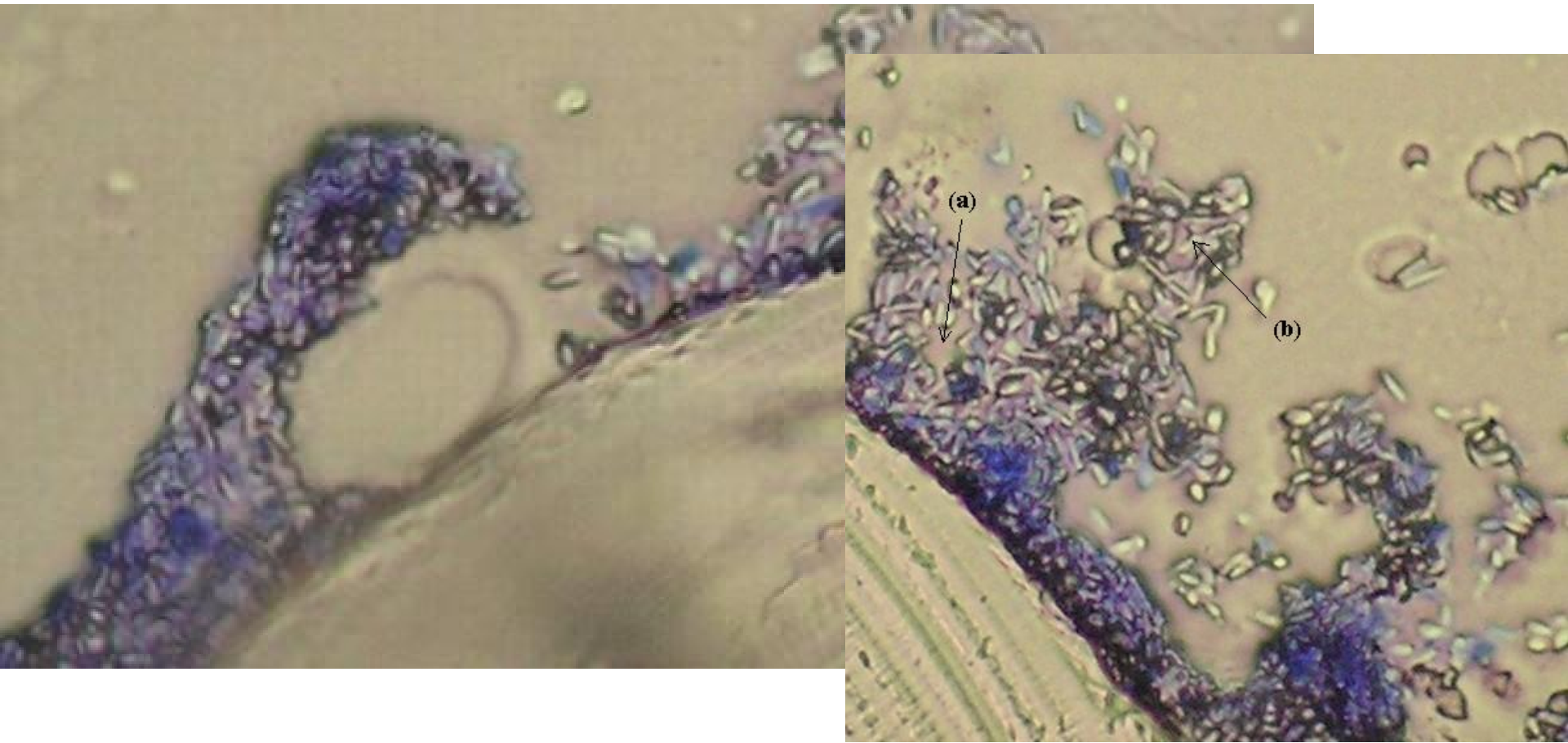
Bacteremia related to artificial material

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)

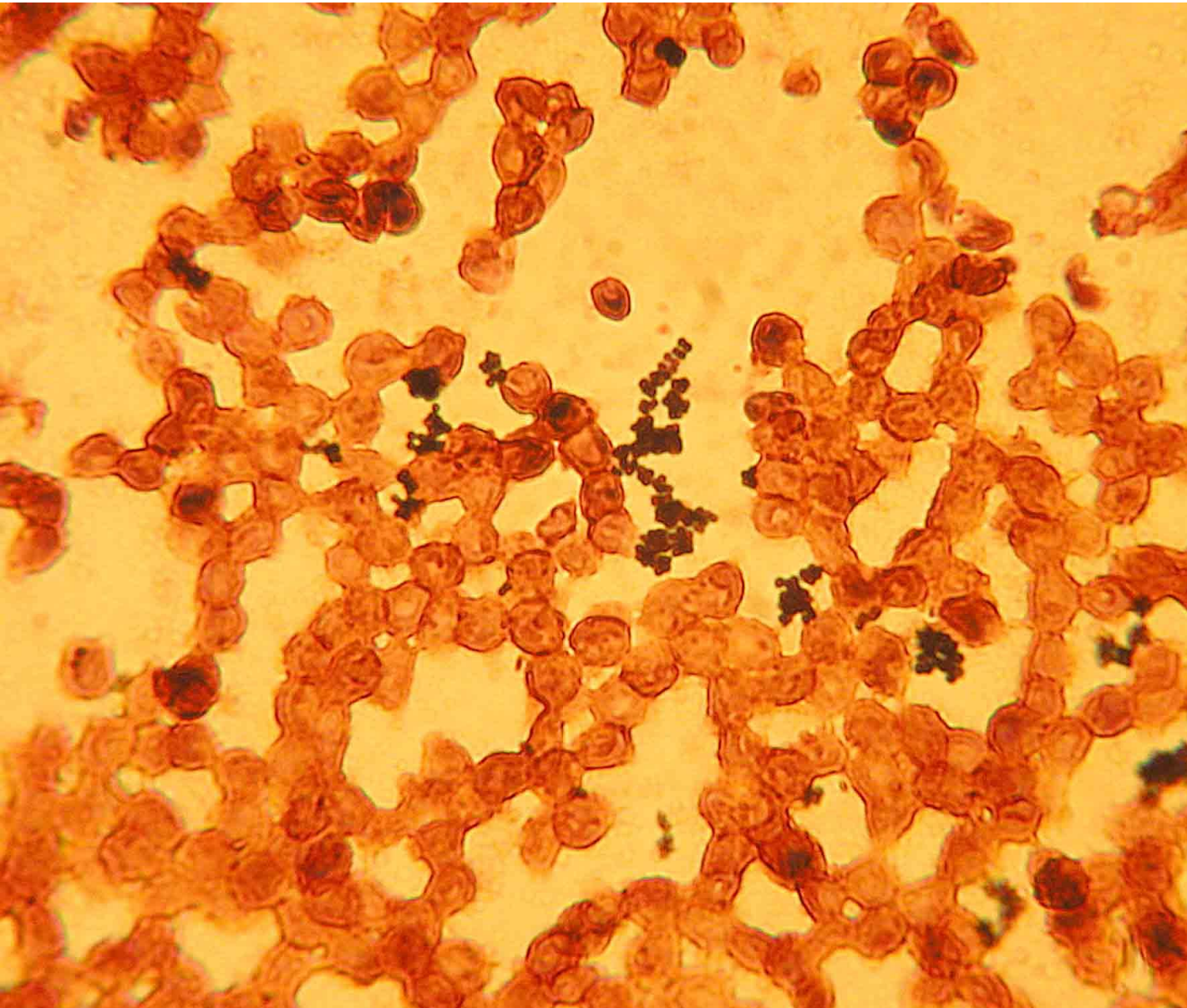
***Streptococcus pyogenes* (often together with necrotizing fasciitis)**

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 venepuncture (i. e. not only central venous catheter)
- **parts of blood catheters**

Contaminants

- **Inproper sampling, insufficient disinfection**
- **Sampling from catheters only and not venepuncture (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**

