Gram-positive cocci: staphylococci and streptococci

Part I

Student completes during the lecture
(Passing the material of Part I during the exercises is a condition for passing the exercise)

Genus: Staphylococcus
Species: **S. aureus**, S. epidermidis, S, saprophiticus
Genus: Streptococcus
Species: **S. pyogenes**, **S. agalactiae**, **S. pneumoniae**, oral streptococci (collectively known as oral streptococci S. viridans - because most of them show the alpha type of hemolysis on blood agar), S. bovis colonizing the intestines
Genus: Enterococcus
Species: E. faecalis, E. faecium

GP cocci include primary pathogenic species (marked in bold) and potentially pathogenic (part of the natural microbiota of the human body).

Microbiota .....

Characteristics of GP cocci – supplement during lecture

Species	Occurrence	Transmission	Diseases in humans
S. aureus	Pathogen, Common carriage	....	Skin infections (folliculitis, impetigo, abscesses, boils, skin cellulitis, wound infections), pneumonia and lung abscesses, purulent osteitis, blood infections (bacteremia, sepsis, septic shock, catheter-related bacteremia), endocarditis, meningitis and brain abscesses, food poisoning
S. epidermidis	.....	Endogenous infection, not transmitted human-to-human	Catheter-related infections of blood and artificial heart valve infections
S. saprophyticus	.....	....	.....
S. pyogenes	.....	By droplets and through direct and indirect contact	....
S. agalactiae	....	....	....
S. pneumoniae	.....	....	....
S. viridans	Oral cavity	Endogenous infection, not transmitted human-to-human	....

S. bovis	Intestines	Endogenous infection, not transmitted human-to-human	.....
E. faecalis	Intestines, urethra in men	Endogenous infection, not transmitted human-to-human	.....
E. faecium			.....

Virulence – .....

Virulence factors of GP species pathogenic to humans

Species	Virulence factors	Role in disease
S. aureus	Protein A Hyaluronidase Coagulase (bound and secreted) Staphylokinase Leukocidin Panton-Valentine **TSST-1 toxin** (toxic shock syndrome toxin) **Exfoliating toxins** **Enterotoxins**	.....
S. pyogenes	M protein Hyaluronic capsule Streptolysin Streptokinase **Pyrogenic toxin SPE** (streptococcal pyrogenic toxin)	.....
S. agalactiae	Capsule Hemolysin	.....

S. pneumoniae	Capsule Pneumolysin Hyaluronidase IgA protease	

Superantigens

Streptococcal (S. pyogenes) non-purulent infections – complications
Rheumatic fever -

Rheumatic heart disease -

Acute glomerulonephritis –

Specific prevention -

A vaccine against pneumococci (S. pneumoniae) is available - it contains capsular antigens (polysaccharide) that can be combined with a protein - then we call such a conjugate vaccine
The vaccine is available in two versions:
a)

b)

Treatment of staphylococcal infections – groups of antibiotics used:
a) **local infections, without dissemination**

b) **infections with the possibility of dissemination/dissemination to the blood**:

Treatment of streptococcal infections – groups of antibiotics used:

Treatment of infections caused by Enterococcus sp. (they are naturally resistant to many groups of antibiotics):

Part II

Diagnostics of infections caused by Gram-positive cocci

1) **Culture on bacteriological media** - blood agar (AK) - allows the detection of the type of hemolysis. Moreover, AK as an enriched substrate enables the growth of demanding species of streptococci; Staphylococci, as a group of undemanding bacteria, also grow on agar enriched without blood. Types of hemolysis on AK:

α hemolysis - appears as a greening of the substrate around bacterial colonies (results from incomplete hemolysis of red blood cells to methemoglobin derivatives, which have a green color)

β hemolysis – appears as a complete discoloration of the medium around the bacterial colonies and is the result of the complete degradation of hemoglobin released from red blood cells

Hemolysis γ – means no hemolysis around bacterial colonies

2) **Identification**

a**) Biochemical tests** – tests that detect specific bacterial metabolites (e.g., catalase, coagulase)

b) **Serotyping** = determination of serological groups of streptococci according to Lancefield (e.g., A, B, C, D, etc.); specific antibodies directed against antigens found on the surface of streptococci, i.e., antigen A, antigen B, etc.

c) **Rapid tests** - tests allowing the quick detection of S. pyogenes antigens (group A) in biological materials collected from patients

d) **Serological tests:**

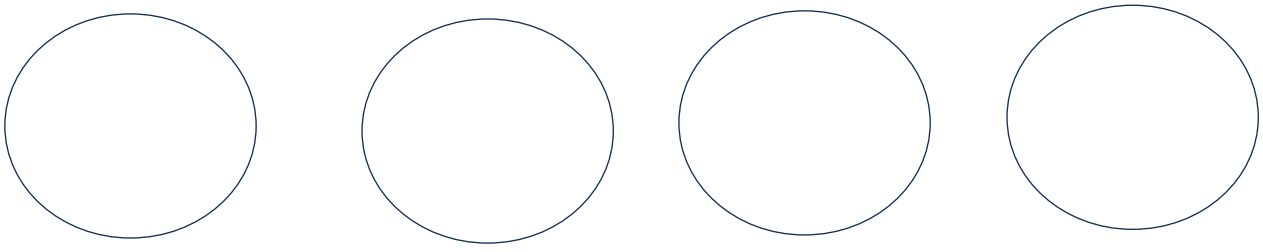
ASO (anti-streptolysin O) – the test detects specific antibodies (detected in the patient's serum) against S. pyogenes streptolysin O (antistreptolysin), the level of which increases in non-purulent complications after streptococcal infections; the level of antistreptolysins in healthy people ranges from 10 to 200 units (IU)/ml; the level of antistreptolysins > 200 IU/ml in adults and 150 IU/ml in children is positive - it indicates recent infection with streptococcus from serological group A (S. pyogenes)

3) Antibiogram - in infections of hospitalized patients and outpatients for whom empirical therapy is ineffective, the resistance of isolated microorganisms to antibiotics active against a given group of bacteria should be determined (antibiograms will be discussed during the exercise on antibiotics)

Practical part – complete the table; enter the serogroup and type of hemolysis on AK

Species	Type of hemolysis	Serologic group
S. pyogens		
S. agalactiae		
S. pneumoniae		
Enterococcus		
Staphylococcus aureus		
Staphylococcus epidermidis		
Streptococcus bovis		

Draw an image from the field of view of the microscope and describe the features: a) species, b) color of the observed bacteria - mark as Gram-positive GP or Gram-negative GN, c) mutual arrangement of bacterial cells (e.g., splits, chains, no characteristic arrangement)



Part III

Topics for discussion with students

1. Why do so many people carry S. aureus? Why can't carriers of Staphylococcus aureus be eradicated?
2. Why do bacterial species that belong to the natural microflora of the human body cause diseases?
3. Why does the capsule protect bacteria from our immune system?
4. Why are cutaneous staphylococci a common cause of catheter-related blood infections?

Questions to help organize knowledge about GP cocci

1. Which GP cocci cause:
a) urinary tract infections?
b) Pneumonia?
c) Pharyngitis?
d) Folliculitis?
e) Boils and abscesses closed? (sort species according to the diseases they cause)
2. Name the exotoxins produced by GP cocci.
3. Name the superantigens and the species of bacteria that produce them.
4. What diseases/syndromes are staphylococcal superantigens responsible for? What about streptococci?
5. Which virulence factors of GP cocci damage human cells?
6. Which GP cocci can cause disseminated infections - name these infections and the bacterial species responsible for them.
7. What role does coagulase play in staphylococcal infections?
8. What is the role of hyaluronidase in bacterial infections?
9. What role do lipoteichoic acids (LTA) play in GP infections?

……..

Credit (date and teacher's signature)