Staphylococcus aureus

Gram (+) cocci, grape-like clusters, facultative anaerobic, catalase and coagulase-positive, and grows on blood agar.

Reservoir: Skin and nose

Transmission: By hands is important

Important diseases
- Abscess: Protein A, coagulase, leukocidin
- Gastroenteritis (food poisoning): Enterotoxin
- Scalded skin syndrome: Exfoliatin
- Toxic shock syndrome: TSST
- Acute bacterial endocarditis
- Hospital Acquired pneumonia
- Others: Various types of skin infections; pimples, impetigo, boils, cellulitis, carbuncles, etc., meningitis, osteomyelitis, and septicemia.

Important Issue: Common cause of nosocomial infections

Antibiotic Resistance
- Beta-lactamase
- Altered binding site for penicillin (MRSA)
- (1) Penicillin → (2) Nafcillin → (3) Vancomycin

Side Effects of Vancomycin
- Thrombophlebitis
- Ototoxicity
- Nephrotoxicity
- Shock

Van has TONs of Load!

1. What is the mechanism of action of penicillin?
   __________________________________________

2. What is the other name for beta-lactamase?
   __________________________________________

3. What is the mechanism of action of Vancomycin?
   __________________________________________

4. What is the bactericidal spectrum of Vancomycin?
   __________________________________________
   Gram __________________!
   Hint: What sign do you see on the van?

I'd rather be a Doc!

Penicillinase Resistant First Generation Antibiotics!

1. Bare Minimum Microbiology Excerpts: Bacteriology/Staph Aureus. Instructed with TALLP Methodology
   Dr. Jahan Eftekar; Northwestern Medical Review, June 2009
5. What is the next DOC for MRSA?

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Indications of Vancomycin

<table>
<thead>
<tr>
<th>Methicillin Resistant Staph aureus</th>
<th>Pseudomembranous colitis</th>
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<tbody>
<tr>
<td>Prosthetic heart valve patients who undergo oral surgery (Staph epidermidis)</td>
<td><em>May also be used for serious cases of resistant streptococcus pneumoniae.</em></td>
</tr>
</tbody>
</table>

6. Between staphylococcus and streptococcus; cultures of one produces grape-like cluster while the other one has chain-like appearance. Which one is which?

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7. Staph aureus is the most common cause of abscess formation. What are the characteristic immune cells within an abscess?

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8. Of the 3 virulent mechanisms causing abscess formation by staph aureus, one is protein A that coats staph with immunoglobulin; and the second one is coagulase that converts fibrinogen to fibrin. What is the function of the 3rd one; leukocidin?

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9. The key organisms to differentiate from Staph are Strep and Listeria. Is Strep catalase-positive or negative?

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10. Is Listeria catalase-positive or negative?

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11. Is enterotoxin of Staph aureus heat stable or labile?

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12. What is scombroid and what are the major sources of poisoning with it?

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13. How long is the incubation period of Staph aureus food poisoning?

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14. How long is the incubation period of Salmonella food poisoning?

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15. S. aureus among other things is one the only two must-know causes of abscess formation. Who is the other important abscess producer?

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16. There are only 5 must-know anaerobic bugs for the exam; one of the five is Bacty (see above); who are the other four?

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17. What is the DOC of Bacillus fragilis?

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18. What is the virulence mechanism of Staph aureus abscess formation?

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<table>
<thead>
<tr>
<th>Food Poisoning</th>
<th>Incubation</th>
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<tbody>
<tr>
<td>Scombroid</td>
<td>Up to 1 hour</td>
</tr>
<tr>
<td>Staph aureus</td>
<td>3 – 8 hours</td>
</tr>
<tr>
<td>Bacillus cereus</td>
<td>3 – 8 hours</td>
</tr>
<tr>
<td>Botulinum</td>
<td>½-day to 1-day</td>
</tr>
<tr>
<td>Salmonella enteritidis</td>
<td>1 – 2 days</td>
</tr>
</tbody>
</table>

Listeria is Cattle-ase positive!

Your List of sources for Listeria should include cattle products!
This is not PCL! Actually it is ACL ("A" for Protein A)! If you like PCL better, then P is for "Protein"!

Note: Protein A binds to Fc-IG and coats Staph with PMNs!

**Rash on Palms and Soles**

<table>
<thead>
<tr>
<th>Toxic Shock Syndrome (S. aureus)</th>
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<tr>
<td>Scalded Skin (S. aureus)</td>
</tr>
</tbody>
</table>

19. **What ionic situation is postulated to provide a suitable medium for production of TSS toxin?**

__________________________________________________________________________

20 **What gram-positive rod causes flaccid paralysis and produces a heat labile toxin?**

__________________________________________________________________________

21. **Is toxin of salmonella heat stable or labile?**

__________________________________________________________________________

About Scombroid Food Poisoning...
Scombroid food poisoning is a seaborne illness that often results from eating decayed fish. It is one of the common types of seafood poisoning; however because of its symptoms, it is often classified as or confused with type I hypersensitivity reaction (food allergy). Symptoms, often self-limited, start within 10-30 minutes of ingesting the fish and include skin flushing, erythema, abdominal cramps, nausea, diarrhea, tachycardia, wheezing and hypotension. It is proposed that histidine that is abundant in many types of fish is converted to histamine via histidine decarboxylase in meat that is stored at very low temperatures. Histamine is heat stable within normal cooking temperatures, so even properly cooked fish can be affected. Note that freezing, cooking and smoking do not destroy the scombroid toxin. A few fish commonly poisoned with scombroid include anchovy, bluefish, herring, mackerel, mahi-mahi, sardine, and yellow fin tuna.

22. **Clinical Settings for Toxic Shock Syndrome:**
A. ____________________________________________
B. ____________________________________________
C. ____________________________________________

23. **What is the number 1 cause of necrotizing fasciitis (flesh eating disease)?**
__________________________________________________________________________

24. **What is the number 2 cause of death in non-coronary ICU patients and 10th overall cause of death in the USA?**
__________________________________________________________________________

25. **What are the major criteria used for diagnosis of sepsis?**
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

Hint: SIRS!

26. **X-ray of the hip of an 8-year-old boy with history of recurrent bone pain is significant for avascular necrosis of the head of femur. Assuming that in the past on three occasions the child has been diagnosed with osteomyelitis, what organism most likely might have caused this finding?**
__________________________________________________________________________

27. **Would you change your answer if you know that the boy has sickle cell anemia?**
__________________________________________________________________________
28. **Who am I (see below)?**

- I am a must-know cousin of Staph aureus but I prefer to live on the skin!
- Often I like to dive into the bodies of 3 groups of people and roam through their bodies. Docs say I give them “bacteremia.”
- You may ask “who are these three?” They are the immunocompromised, the hospital patients with Foley urine catheters or IV lines, and the patients with prosthetic devises such as valves or joints!
- I just don’t know what it means, but Lab technicians often say that I am a catalase-positive and coagulase-negative creature!
- I just hate vancomycin!
- Now can you tell me who am I?

29. **There are only three must know staph family members for the exam. The most commonly tested one is Staph aureus. The second one is Staph epidermidis that you just got introduced to him. Who is the third one?**

**Hint:** It is the second most common cause of UTI (ranks after E. coli) in ambulatory women.

**Hint:** It is coagulase negative!

30. **What are the top 3 bacterial causes of sepsis as a result of skin infections?**

31. **Among β-lactamase resistant penicillins that can act on Staph aureus (NO MDs!) Naftillin is by far most preferable over Methicillin; why?**

32. **Treatment strategy of staph aureus and Staph epidermidis endocarditis is similar because of what important issue?**
5. Bare Minimum Microbiology Excerpts: Bacteriology/Staph Aureus. Instructed with TALLP Methodology  
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Answers

1. **Penicillins** bind to penicillin binding proteins (cell wall transpeptidases) and inhibit cross-linkage of the peptidoglycan units of the bacterial cell wall.

2. **Penicillinase**

3. **Vancomycin** inhibits cell wall synthesis in Gram-positive bacteria. In contrast to penicillins that inhibit cross linkage of the peptidoglycan subunits, it acts by binding to precursors of peptidoglycan subunits rather than by interacting with the transpeptidases. It is proposed that it inhibits incorporation of N-acetylmuramic acid and N-acetylglucosamine peptide subunits into the peptidoglycan matrix.

4. **Gram-positive!**

5. The next DOC for MRSA is trimethoprim-sulfamethoxazole (Bactrim)

6. Staph, grape-like and Strep; chain-like!

7. PMNs!

8. Leukocidin is leukocidal and destroys PMNs!

9. **Strep** is catalase-negative and listeria positive

10. Listeria is catalase-positive!

11. Staph toxin is heat stable!

12. See the note about scombroid poisoning

13. 3 to 8 hours!

14. **Salmonella** food poisoning incubation is 1 to 2 days!

15. Bacteroides fragilis!

16. The other strict anaerobes are the four clostridial members (tetani, botulinum, perfringens and difficile)

17. Clindamycin and metronidazole

18. **Protein A!**

**Note:** Answer for “rash on palms and soles” will progressively become more apparent as further bacteria are covered during the course!

19. **Hypomagnesemia!**
   It is postulated that tampons absorb various ions including magnesium.

**Note:** Staph aureus is normal vaginal flora in 8-10% of females. But **heavy growth is unusual.**

20. Clostridium botulinum causes flaccid paralysis

21. Salmonella toxin is heat labile

22. The 3 settings for TSS are tampons, nose-packing and wound dressing!

23. **Strep pyogenes** is the number one cause of necrotizing fasciitis. Other major causes are Staph aureus, Clostridium perfringens and bacteroides fragilis!

24. Sepsis is the number 2 cause of death in non-coronary ICU and 10th overall cause of death in the USA.  
**Note:** Recent data suggest that sepsis is the number one cause of death in non-coronary ICU

25. Criteria for diagnosis of sepsis: Presence of infection plus 2 or more signs of Systemic Inflammatory Response Syndrome (SIRS): Tachycardia; Hypo or hyperthermia; Tachypnea (hypocapnia); and WBC (less than 4000 or more than 12000/mm3!

26. Answers to the two questions related to the 8-year-old boy: The most likely infectious cause of osteomyelitis is Staph aureus.

27. Children with sickle cell disease due to splenetic malfunction or splenectomy are uniquely susceptible to frequent osteomyelitis as a result of salmonella infections.  
**Note:** The cause of avascular necrosis is often vascular and aseptic; but it is postulated that frequent infections and resultant inflammation of the bone may cause stenotic damages to the vasculature leading to avascular necrosis of the hip and femoral head!

28. Staphylococcus epidermidis!

29. Staphylococcus saprophyticus!

30. Top 3 causes of sepsis as a result of skin infections are Strep pyogenes, Staph aureus, and Pseudomonas!

31. Meticillin causes serious nephrotoxicity!

32. Most Staph epidermidis strains are currently MRSA-like and they are resistant to nafcillin!