Excerpts
Bare Minimum Microbiology Review

Staph aureus
**Staphylococcus aureus**

- Gram-positive cocci, grape-like clusters, facultative anaerobic, catalase and coagulase-positive, and grows on blood agar.
- **Reservoir:** Skin and nose;
- **Transmission:** By hands is an important issue
- **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: (1) Beta-lactamase (Penicillinase); and (2) Altered binding site for Penicillin (MRSA)
- **Treatment:** Nafcillin (for all but MRSA), and Vancomycin for MRSA

**Side Effects of Vancomycin**

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?

5. What is the next DOC for MRSA?

**Indications of Vancomycin**

- Methicillin Resistant Staph aureus
- Pseudomembraneous colitis
- Prosthetic heart valve patients who undergo oral surgery (Staph epidermidis)

* May also be used for serious cases of resistant streptococcus pneumoniae.
6. **Staphylococcus and streptococcus cultures produce either a grape-like cluster or have a chain-like appearance. Which one is which?**

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

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

9. **The key organisms that one must differentiate from Staph are Strep and Listeria. Is Strep catalase-positive or negative?**

10. **Is Listeria catalase-positive or negative?**

Your List of sources for Listeria should include cattle products!

Listeria is Cattle-ase positive!

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

<table>
<thead>
<tr>
<th>Food Poisoning</th>
<th>Incubation</th>
</tr>
</thead>
<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>½-day to 1-day</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>

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

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

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

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

   Hint 1: Anaerobic
   Hint 2: Gram-negative rod
   Hint 3: Bowel surgery
   Hint 4: Metronidazole and Clindamycin

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

17. **What is the DOC of Bacillus fragilis?**

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

   1. **Protein A:**
   2. **Coagulase:**
   3. **Leukocidin:**

   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>T</th>
<th>Oxic Shock Syndrome (Staph aureus)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Hooded Skin Syndrome (Staph aureus)</td>
</tr>
</tbody>
</table>

   Not that many diseases can cause rash on palms and soles. Solve the puzzle by adding more bugs or diseases to the right column until you figure out the hidden word of the first column. Note that the answer will become apparent as we learn about more bugs.
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 salmonella toxin 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.

**Diseases Caused By Staph aureus**

<table>
<thead>
<tr>
<th>Skin Infections</th>
<th>Pneumonia</th>
<th>SIRS!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteomyelitis</td>
<td>Acute Endocarditis</td>
<td>SOFT PAINS</td>
</tr>
<tr>
<td>Food Poisoning</td>
<td>Infective arthritis</td>
<td>For Staph aureus diseases</td>
</tr>
<tr>
<td>Toxic Shock Syndrome</td>
<td>Necrotizing Fasciitis</td>
<td></td>
</tr>
<tr>
<td>Sepsis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 the 10th overall cause of death in the USA?

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

**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 the femur. 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 knew that the boy has sickle cell anemia?**

**28. Who am I?**
- 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, hospital patients with Foley urine catheters or IV lines, and patients with prosthetic devices 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, which you were just introduced to. 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?**

- Staphylococcus aureus
- Staphylococcus epidermidis
- Staphylococcus saprophyticus

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

Nafcillin has a longer half-life and is less likely to cause β-lactamase inhibition, making it a more effective treatment choice.

**32. The treatment strategy of staph aureus and Staph epidermidis endocarditis is similar because of what important issue?**

The treatment strategy is similar because both bacteria are sensitive to β-lactam antibiotics.

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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-acetylgalactosamine peptide subunits into the peptidoglycan matrix.
4. Gram-positive!
5. The next DOC for MRSA is trimethoprim-sulfamethoxazole (Bactrim). Lately, there has also been emergence of Vancomycin-Resistant Staph Aureus (VRSA). A few newly developed antibiotics that can act on them are Linezolid, and daptomycin.
6. Staph is grape-like and Strep is chain-like!
7. PMNs!
8. Leukocidin is leukocoidal and destroys PMNs!
9. Strep is catalase-negative and listeria is catalase 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 attracts PMNs; coagulase coagulates blood; and leukocidin kills the neutrophils!

**Note:** Answer for “rash on palms and soles” will progressively become more apparent as further bacteria are covered and we add in more words into the puzzle during the course.

19. Hyponatrememia! It is postulated that tampons absorb various ions including magnesium. **Note:** Staph aureus is a 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. The most likely infectious cause of osteomyelitis is Staph aureus (also see answer to question 27),
27. Children with sickle cell disease due to splenectomy 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. Metilcin causes serious nephrotoxicity
32. Most Staph epidermidis strains are currently MRSA-like and they are resistant to nafcillin!