Study Guide
MICROBIAL DIVERSITY
Brock Ch. 12, III

This study guide covers Brock Ch. 12, part III: the phylum called '**the Gram-positive bacteria**'. Note that not every Gram-positive bacterium is in this phylum – but most are. Make sure that you know what features distinguish Gram-positive and Gram-negative bacteria! (See class notes.)

1. Look back at the tree for the domain Bacteria, presented as Fig. 12.1 (page 353). What is the sister group of the Gram-positive bacteria?

   The group you named above, plus the Gram-positive bacteria, are sister to what?

   What are the two divisions within the Gram-positive bacteria?

   What do these divisions refer to?

2. Now we'll start thinking about the Gram-positive bacteria. We'll start with the **NONSPORULATING GRAM-POSITIVE BACTERIA. Cocci in this group are resistant to drying and salt.** Key genera are *Staphylococcus, Micrococcus, Sarcina, Streptococcus, Lactobacillus*.

   A. Based on the class notes, draw the general shape of each genus below. Then, use the book to fill in the rest of the table. Under oxygen use, indicate strict aerobe, strict anaerobe, facultative aerobe, or facultative anaerobe. Under selective media type, indicate what components of the growth medium can be used to selectively isolate that group.

	Drawing of general shape	High (H) or low (L) GC?	Ferments?	Oxygen use
Staphylococcus				
Micrococcus				
Sarcina				
Streptococcus				
Lactobacillus				

On the table above, circle the genus that includes a yellow-pigmented species commonly associated with pimples, pneumonia, arthritis, etc. What is the name of this species?

Put a star by the genus that is common on skin, but also is found on inanimate objects such as dust particles.

Put a rectangle around the genus that contains one of the only species of bacteria that can grow in the human stomach (highly acidic conditions).

Put a triangle next to the genus that contains the common bacteria in dairy products, including the species used in yogurt preparation.

B. What is special about the relationship of **lactic acid bacteria** with oxygen? Be sure that you can define this unique characteristic.

C. Lactic acid bacteria are characterized by…(FYI)

(Gram-positive)
(Bacillus and coccus forms)
Limited biosynthetic activity
Need for vitamins from the environment
(The characteristic you described above)
Lack of electron transport phosphorylation

D. What are the two major subgroups in the lactic acid bacteria, and how can they be told apart?

E. Now, go back to the table that you filled in on Page 1 of this study guide. Indicate whether each genus includes homo- or heterofermentation. What is the difference between these fermentative lifestyles?

F. You have a *Streptococcus* sample from a human. You need to identify it to subgroup. What are the subgroups, and what three characteristics could you use to clearly differentiate between the two subgroups?

3. Now, we'll talk about the **ENDOSPORE-PRODUCING GRAM-POSITIVE BACTERIA**. An **endospore** is a highly heat-resistant, thickwalled, differentiated cell produced by endospore-forming, Gram-positive bacteria. Important: they're called 'endospores' because they're formed **within the bacterial cell**.

   A. Endospore-forming bacteria are most commonly found in soil, and the most commonly studied genera are…

   B. Are these in the high- or low-GC group of the Gram-positive bacteria?

   C. Because endospores are highly resistant to heat, what's one counter-intuitive way to selectively isolate the endospore-forming bacteria?

   D. Describe the human uses of the toxin produced by *Bacillus thuringiensis*.

   E. Name several diseases caused by *Clostridium* species.

4. Imagine that you were handed a culture and asked to determine whether it contained *Staphylococcus* or *Bacillus*. What would you do? (Describe your logic clearly. Imagine that you have information about its genome, and can culture it, and can look at it under a microscope.)

5. Let's tie these sections together. So far, we've been talking (in this study guide) about GRAM-POSITIVE BACTERIA, which are highly diverse. The LOW-GC gram-positive bacteria contain (1) species that do not form endospores, (2) endospore-forming species, and (3) species that lack cell walls (the mycoplasmas, which we'll discuss next).

   Mycoplasmas are thought to be the smallest organisms capable of living without having to colonize other cells. They lack cell walls and, as pointed out above, are low-GC, Gram-positive bacteria. They have simple cell structure and small genomes. Because they lack cell walls, they don't show a positive staining reaction to Gram stain.

   A. Why, then, do we call them Gram-positive?

   B. Remember that one of the major functions of the bacterial cell wall is to prevent osmnotic lysis. Given that the mycoplasmas lack cell walls, what do they have to prevent osmotic lysis?

   C. What's the smallest known size of mycoplasma cells capable of growth? How does this compare to the typical cell size of 'normal' prokaryotes? How does the genome size of mycoplasmas compare with that of *E. coli*?

   D. Why does penicillin not work against mycoplasmas?

6. **Now, we'll shift to the high-GC Gram-positive bacteria.** We'll focus on four groups: Corynebacteria, Propionic acid bacteria, *Mycobacterium,* and *Streptomyces* + the other actinomycetes.

Corynebacteria have **snapping division**. What is that?

Propionic bacteria are famous for what? What compounds do they make that help produce this distinctive product?

Mycobacterium includes the causal agent of what human disease? What special material is present in the lipids of this bacterium? Why is this material important in the history of microbiology?

Streptomyces and other actinomycetes are distinctive because they grow as branching filaments to form a mycelium (rather than in the forms we've described thus far), and they do form spores. Thus, these guys are filamentous, spore-forming, high GC, gram-positive bacteria. Nicely enough, they form a coherent phylogenetic group.

Streptomyces typically grow in alkaline and neutral soil and are responsible for the 'soil' smell thanks to the production of ***geosmins*.**

Streptomyces is famous for the production of antibiotics. More than 60 products of these bacteria are used in medicine, agriculture, and industry. However, the ecology of this group remains poorly understood.

Note the wild morphology of the spore-bearing structures in Fig. 12.74 and Fig. 12.75.

Check out the activity of the chemical classes of antibiotics produced by *Streptomyces*. Some of the common names will be familiar to you. Be sure that you can list the name of one chemical class, a common name, and the activity of that antibiotic.

Imagine that you were told that you had an infection caused by *Staphylooccus*. Even though you understand the need to not over-prescribe antibiotics (due to the environmental consequences of antibiotic use and the problems associated with antibiotic resistance), you're in bad shape, so you agree to take something to combat the infection. A surprisingly clueless pharmacist gives you the choice of taking streptomycin or erythromycin. Which do you choose, and why?