

# MICROBIOLOGY FUNDAMENTALS

## Section 1 - Bacterial Structures

- I. There are several bacterial structures to be familiar with for board exams. These structures can help bacteria infect host cells and survive. Some structures are unique to certain groups and can be useful in distinguishing bacterial organisms.

Structure	Description
Cytoplasmic membrane	<ul style="list-style-type: none"> <li>Phospholipid bilayer</li> <li>Contains lipoteichoic acids in gram-positive bacteria → stimulates host immune response via TNF-<math>\alpha</math> and IL-1 release</li> <li>Contains penicillin-binding proteins (PBPs)</li> </ul>
Cell wall	<ul style="list-style-type: none"> <li>Peptidoglycan that provides rigidity and structural support to cell</li> <li>Thick in gram-positive bacteria (gram staining with crystal violet causes blue appearance)</li> <li>Thin in gram-negative bacteria</li> <li>Absent in Mycoplasma species which have added sterols to maintain stability (must grow on Eaton's agar)</li> <li>Contains mycolic acid in Mycobacteria species (must use acid-fast stain)</li> </ul>
Flagella	<ul style="list-style-type: none"> <li>Provides bacterial motility</li> </ul>
Pilus (fimbria)	<ul style="list-style-type: none"> <li>Allows bacteria to bind to host cells</li> <li>Allows bacteria-bacteria binding during conjugation</li> </ul>
Glycocalyx (capsule or slime layer)	<ul style="list-style-type: none"> <li>Network of polysaccharides</li> <li>Slime layer: disorganized and loosely attached to cell wall → creates biofilm on prosthetics (eg, <i>S. epidermidis</i>)</li> <li>Capsule: organized and firmly attached to cell wall → protects from phagocytosis (targeted by many vaccines)</li> <li>Note: the capsule of <i>Bacillus anthracis</i> is made of a protein network of poly-D-glutamate</li> </ul>
Outer membrane	<ul style="list-style-type: none"> <li>Only present in gram-negative organisms (gram counter-staining with safranin causes red appearance)</li> <li>Contains porins → transfer of nutrients</li> <li>Contains lipopolysaccharides (LPS: lipid A, core polysaccharide, and O antigen)</li> <li>Lipid A stimulates host immune response via TNF and IL-1 release → fever, shock, diarrhea</li> </ul>
Periplasm	<ul style="list-style-type: none"> <li>Located between outer membrane and cytoplasmic membrane in gram-negative bacteria</li> <li>Contains hydrolytic enzymes (eg, <math>\beta</math>-lactamases)</li> </ul>
Endospore	<ul style="list-style-type: none"> <li>Layer formed during dormant state → resists heat, chemicals, dehydration and starvation → survival of bacteria</li> <li>Only present in gram-positive organisms (<i>Clostridium</i> and <i>Bacillus</i>)</li> <li>Center containing DNA and dipicolinic acid (DPA) → cytoplasmic membrane (spore core) → peptidoglycan wall (spore cortex) → cytoplasmic membrane → keratin-like protein wall (spore coat) → exosporium (present only in <i>B. anthracis</i> and <i>B. cereus</i>)</li> </ul>

Table 5.1.1 - Bacterial structures

## Gram Positive

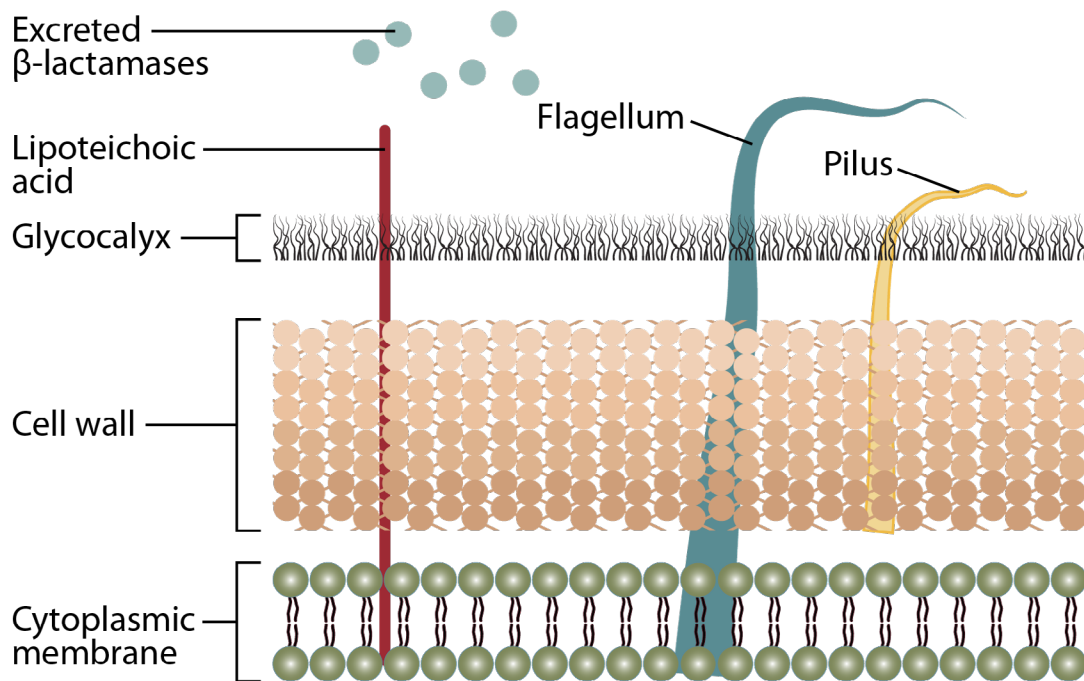


Figure 5.1.1 - Gram positive bacterial envelope

## Gram Negative

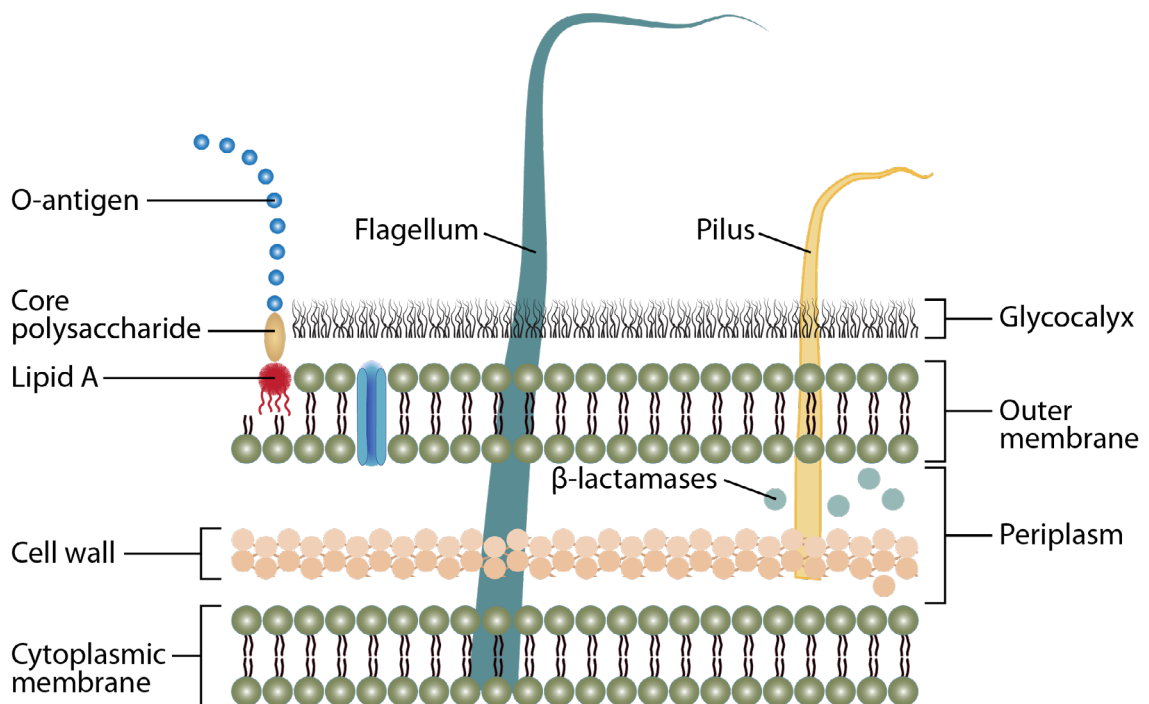


Figure 5.1.2 - Gram negative bacterial envelope

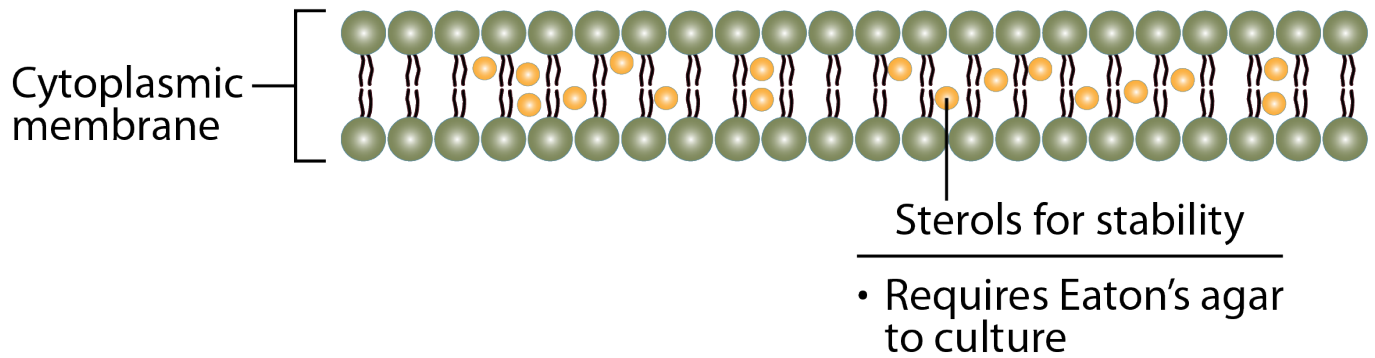


Figure 5.1.3 - Envelope of Mycoplasma spp.

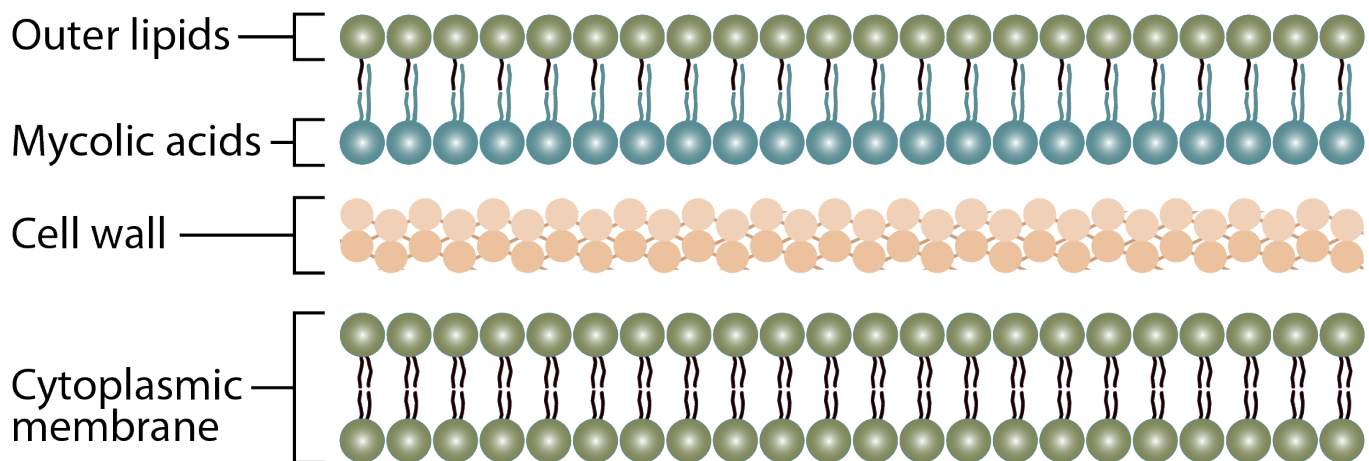
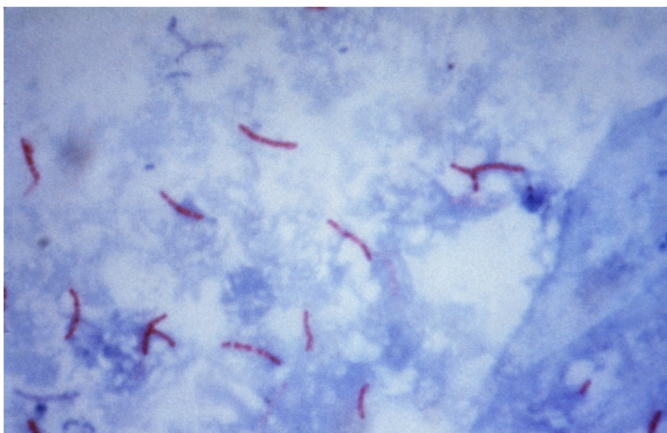


Figure 5.1.4 - Envelope of Mycobacteria spp.



CDC/Dr. George P. Kubica [Public domain], via Wikimedia Commons

Figure 5.1.5 - Acid-fast stain of Mycobacterium Tuberculosis

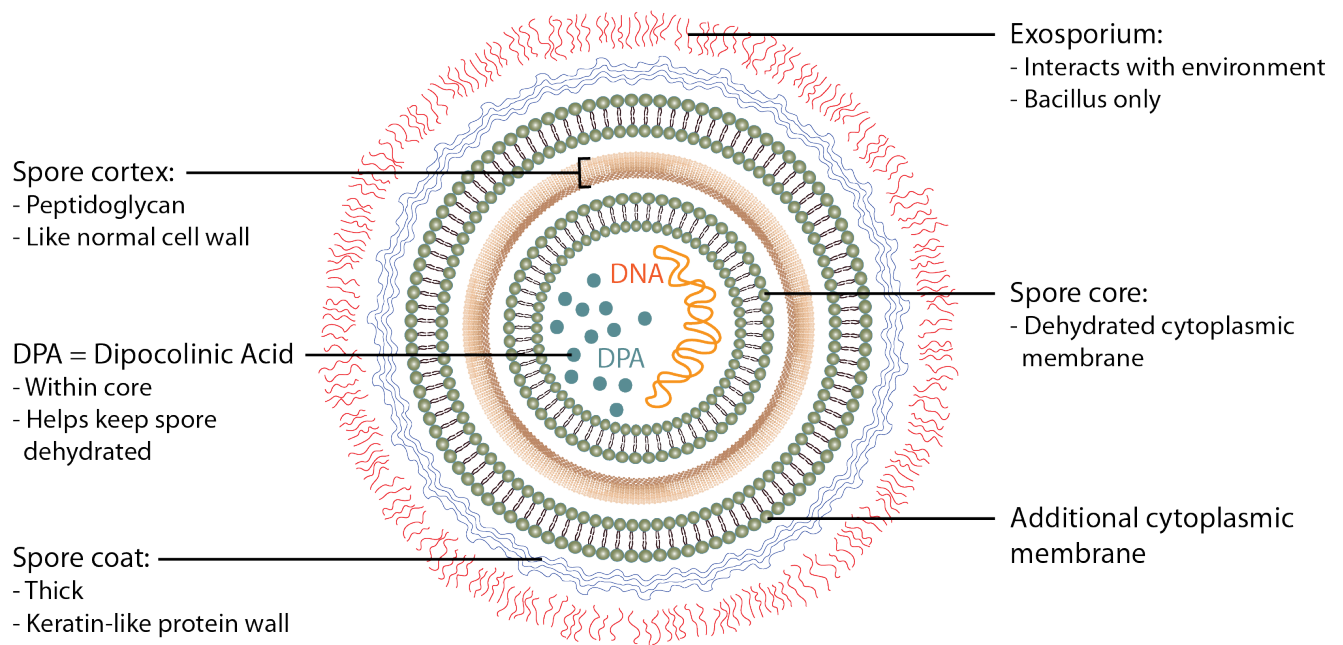


Figure 5.1.6 - Bacterial endospore

#### A. Polymerases in bacteria

1. DNA polymerase (replication → more DNA)
  - a) Mistakes can harm progeny
2. RNA polymerase (transcription → mRNA)
  - a) Mistakes do not harm progeny

## REVIEW QUESTIONS



1. A researcher is attempting to create a novel staining agent that will only bind to certain bacterial species. This species cannot form an endospore, does not contain mycolic acids, and contains only one phospholipid bilayer. Which of the following does the organism described most likely possess?
    - A. A cytokine inducing structure in outer membrane
    - B. A layer that tightly binds to the safranin counterstain
    - C. A protein structure allowing for motility
    - D. A relatively thin layer of peptidoglycan
- **Correct answer: C**
    - The question stem describes a gram positive organism
      - Contains only one phospholipid bilayer, so its not gram negative
      - Does not contain mycolic acids, so its not mycobacteria
    - Gram positive organisms may contain flagella
  - Choice A is incorrect because this describes the endotoxin of gram negative bacteria
  - Choice B is incorrect because Safranin binds to the outer membrane found only in gram negative bacteria
  - Choice D is incorrect because thin peptidoglycan layers are found in Mycobacteria and gram negative organisms, not in gram positive bacteria