Difference Between Gram Positive and Gram negative Bacteria

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Difference Between Gram Positive and Gram Negative Bacteria

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Main Difference – Gram Positive vs Gram Negative Bacteria

Gram positive and gram negative bacteria are the two types of bacteria, differentiated by the gram staining technique. Gram staining was developed by Cristian Gram in 1884. The stain used during the technique is crystal violet. Gram positive bacteria are more susceptible to antibiotics due to the lack of an outer membrane. Since gram negative bacteria contain an outer membrane, they are less susceptible to antibiotics. Therefore, gram negative bacteria are more pathogenic compared to gram positive bacteria. The **main difference** between gram positive and gram negative bacteria is that **gram positive bacteria contain a thick peptidoglycan cell wall along with teichoic acid, allowing the bacteria to stain in purple during gram staining whereas gram negative bacteria contain a thin peptidoglycan cell wall with no teichoic acid, allowing the cell wall to stain in pink during counter staining**.

This article explores,

GRAM NEGATIVE BACTERIA

Gram positive bacteria retain the crystal violet stain during gram staining	Gram negative bacteria do not retain the crystal violet stain during gram staining
Appear in purple color under the microscope	Appear in pink color under the microscope
Outer membrane is present	Outer membrane is absent
Peptidoglycan layer is thick and multilayered	Peptidoglycan layer is thin and single-layered
Periplasmic space is absent	Periplasmic space is present
Cell wall is around 20-80 nm	Cell wall is around 5-10 nm
Cell wall is smooth	Cell wall is wavy
Cell wall contains virtually non lipopolysaccharide content	Cell wall high lipopolysaccharide content
Lipid and lipoprotein content is low in the cell wall	Lipid and lipoprotein content is high in the cell wall
More susceptible to anionic detergents	Less susceptible to anionic detergents
Examples include actobacillus, Actinomyces, Bacillus, Streptococci, Clostridium & Corynebacterium	Examples include Acetobacter, Chlamydia, Borrelia, Bortadella, Burkholderia, and Enterobacter

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Bacteria which retain the crystal violet stain during gram staining, giving the positive color for tests, are called gram positive bacteria. They appear in purple color under the microscope by staining. The thick peptidoglycan layer present in the gram positive bacteria is responsible for retaining the stain even after decolorization. One of the most characteristic features of gram positive bacteria is that they are more susceptible to antibiotics due to a lack of an outer membrane. The gram staining of rod-shaped Bacillus species is shown in *figure 1*.

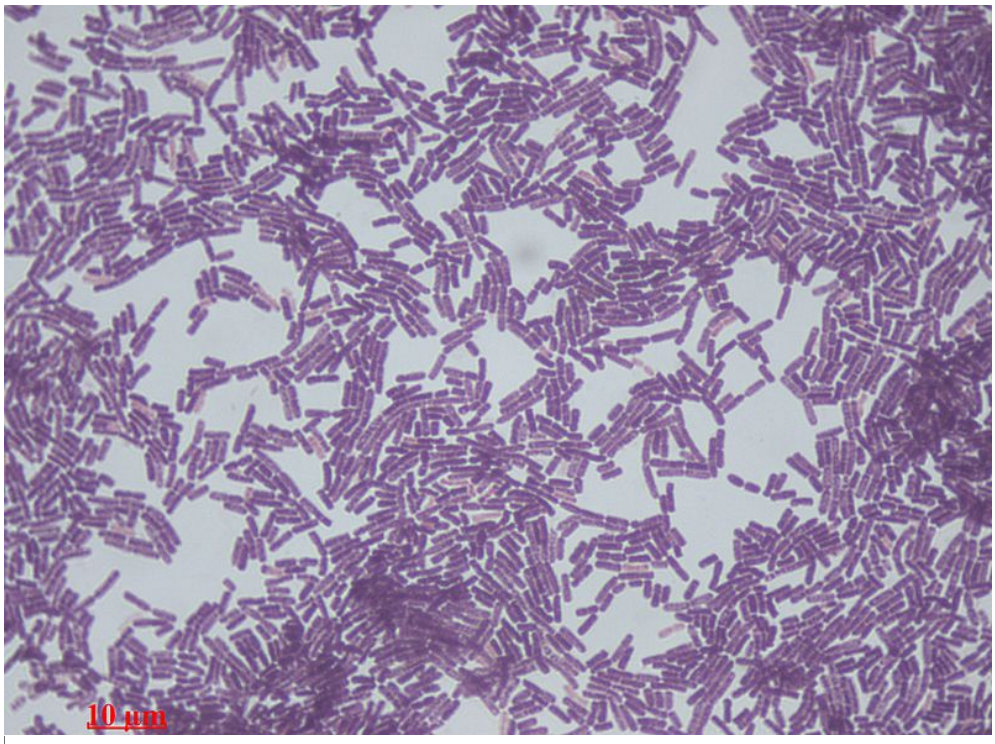

Figure 1: Gram Stained Rod-shaped Bacillus Species

Cell Wall Structure of Gram Positive Bacteria

Gram positive bacteria contain a continuous cell wall called the sacculus, which is 20-80 nm thick. The cell wall is composed of peptidoglycan known as murein. Peptidoglycans contain a glycan backbone, which is made up of both N-acetylated muramic acid and glucosamine. In gram positive bacteria, this glycan backbone is highly cross-linked with oligopeptides. The β-lactam antibiotics targets the enzyme transpeptidase which is involved in cross-linking. In some gram positive bacteria, teichoic acid is found, covalently linked to the peptidoglycan backbone. Teichoic acid bears a strong negative charge and they are strongly antigenic. The structure of gram positive cell wall is shown in *figure 2*.

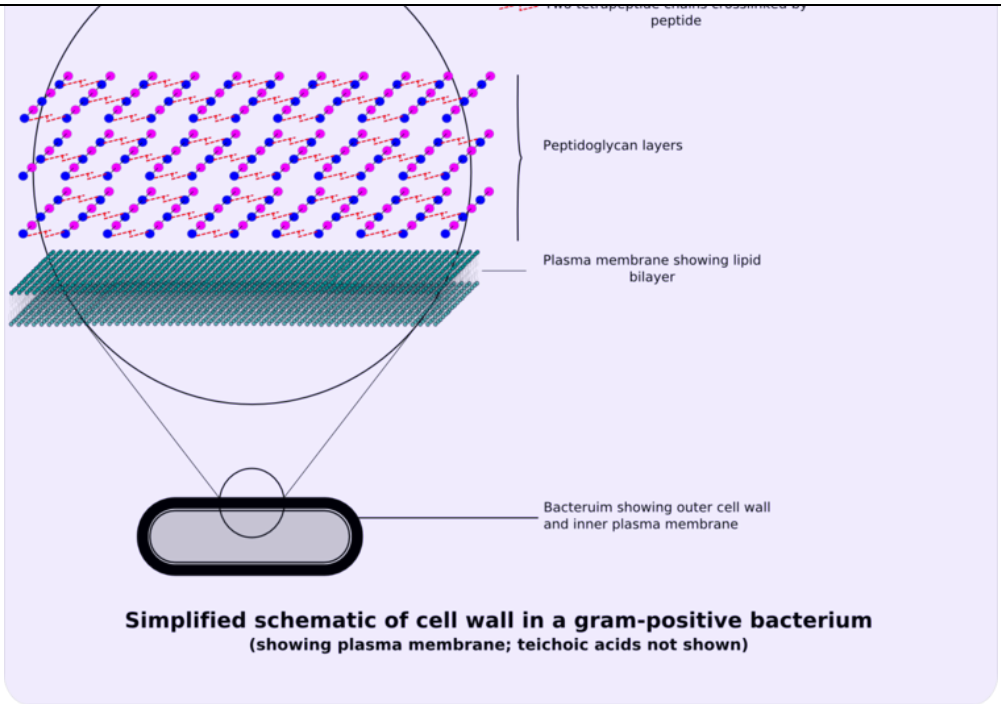

Figure 2: Gram Positive Cell Wall

What are Gram Negative Bacteria

Bacteria which do not retain the crystal violet stain during gram staining are called gram negative bacteria. The peptidoglycan layer, which is responsible for retaining the crystal violet stain, is thin in gram negative bacteria and it is sandwiched between the inner cytoplasmic membrane and the outer membrane of the bacteria. Therefore, gram negative bacteria can be stained by the counter stain, safranin during the gram staining technique, giving the red to pink color. *Escherichia coli* is gram negative and is used as the model organism in most bacterial studies. Gram negative bacteria are more pathogenic due to their less susceptibility to antibiotics. Antibiotic resistance of the gram negative bacteria is given by the outer membrane present in these bacteria. *Neisseria gonorrhoeae*, *Pseudomonas aeruginosa* and *Yersinia pestis* like gram negative bacteria are pathogenic.

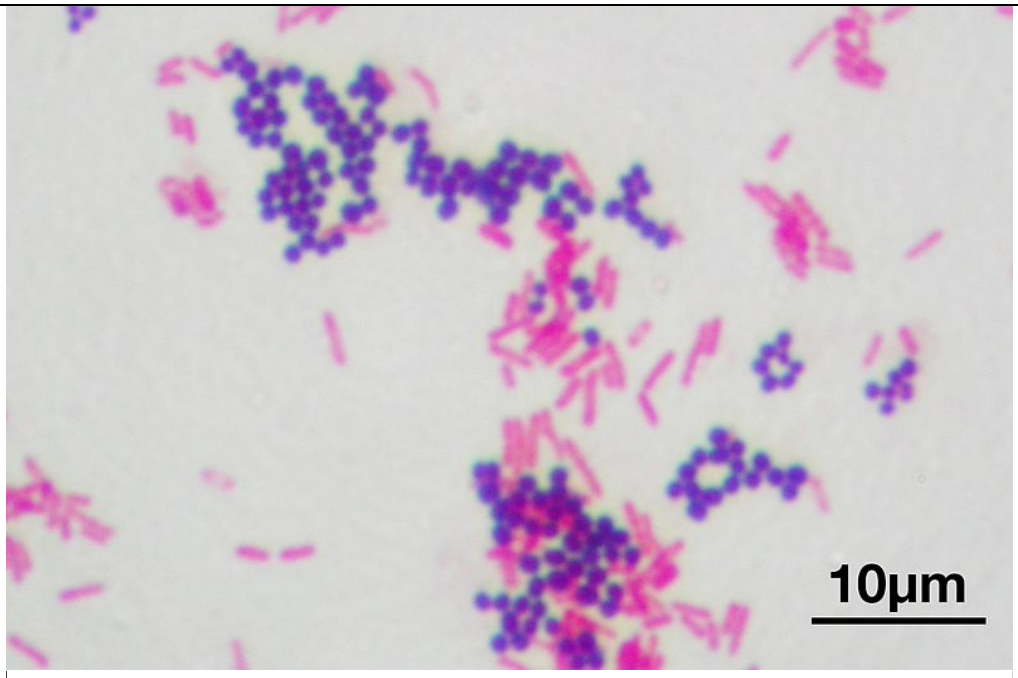

Figure 3: Gram Negative Cocci and Gram Positive Rod-shaped Bacteria in gram staining

Cell Wall and Cell Envelope Structure of Gram Negative Bacteria

The cell wall of gram negative bacteria is 5-10 nm thick, containing a monolayer of peptidoglycan. The peptidoglycan backbone is partially cross-linked in gram negative bacteria. Teichoic acid is not found in the cell wall of gram negative bacteria. Gram negative bacteria are composed of a cell envelope in the outside of the cell wall, called the outer membrane, which is 7.5-10 nm thick. In the outer membrane of the gram negative bacteria, lipopolysaccharides which serves as endotoxins are found. The outer membrane is non-covalently anchored into lipoproteins, called Braun's lipoproteins, which are covalently bound to the peptidoglycan layer. Inner and the outer membrane adhere to each other by hundreds of Bayer patches.

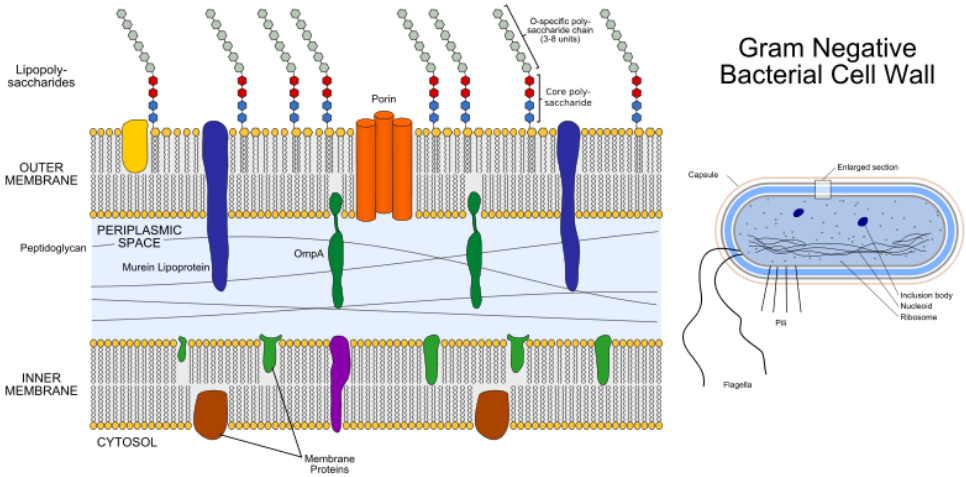

Figure 4: Gram Negative Cell Wall

Difference Between Gram Positive and Gram Negative Bacteria

Gram Positive Bacteria: Gram positive bacteria retain the crystal violet stain during gram staining, giving the positive result.

Gram Negative Bacteria: Gram negative bacteria do not retain the crystal violet stain during gram staining, giving the negative result.

Appearance under Microscope

Gram Positive Bacteria: Gram positive bacteria appear in purple color under the microscope.

Gram Negative Bacteria: Gram negative bacteria appear in pink by retaining the counterstain safranin.

Outer Membrane

Gram Positive Bacteria: The outer membrane is present in gram positive bacteria.

Gram Negative Bacteria: The outer layer is absent in gram negative bacteria.

Peptidoglycan Layer

Gram Positive Bacteria: The peptidoglycan layer is thick and multilayered.

Gram Negative Bacteria: The peptidoglycan layer is thin and single-layered.

Periplasmic Space

Gram Positive Bacteria: The periplasmic space is absent in gram positive bacteria.

Gram Negative Bacteria: The periplasmic space is present in gram negative bacteria.

Thickness of the Cell Wall

Gram Positive Bacteria: The thickness of the cell wall in gram positive bacteria is around 20-80 nm.

Gram Negative Bacteria: The cell wall of gram negative bacteria is around 5-10 nm thick.

Texture of the Cell Wall

Gram Positive Bacteria: The cell wall of gram positive bacteria is smooth.

Gram Negative Bacteria: The cell wall of gram negative bacteria is wavy.

Gram Positive Bacteria: The cell wall of gram positive bacteria contains virtually none lipopolysaccharide content.

Gram Negative Bacteria: Gram negative bacteria contain high lipopolysaccharide content in their cell wall.

Lipid and Lipoprotein Content

Gram Positive Bacteria: Lipid and lipoprotein content is low in the cell wall of gram positive bacteria.

Gram Negative Bacteria: Lipid and lipoprotein content is high in the cell wall of gram negative bacteria.

Murein

Gram Positive Bacteria: The cell wall of gram positive bacteria contains 70-80% murein.

Gram Negative Bacteria: The cell wall of the gram negative bacteria contains 10-20% murein.

Pores on the Outer Membrane

Gram Positive Bacteria: Porins are absent in the outer membrane of gram positive bacteria.

Gram Negative Bacteria: Porins or hydrophilic channels are present in the outer membrane of gram negative bacteria.

Teichoic Acid

Gram Positive Bacteria: Teichoic acid is present in the membrane of gram positive bacteria.

Gram Negative Bacteria: Teichoic acid is absent in the membrane of gram negative bacteria.

Basal Body of the Flagellum

Gram Positive Bacteria: The basal body of the flagellum contains two rings in gram positive bacteria.

Gram Negative Bacteria: The basal body of the flagellum contains four rings in gram negative bacteria.

Pili

Gram Positive Bacteria: Gram positive bacteria do not contain pili.

Gram Negative Bacteria: Gram negative bacteria contain pili.

Gram Positive Bacteria: Mesosomes are more prominent in gram positive bacteria.

Gram Negative Bacteria: Mesosomes are less prominent in gram negative bacteria.

Resistance to Physical Disruption, Sodium Azide, and Drying

Gram Positive Bacteria: The resistance to physical disruption, sodium azide, and drying is high in gram positive bacteria.

Gram Negative Bacteria: The resistance to physical disruption, sodium azide, and drying is low in gram negative bacteria.

Susceptibility to Anionic Detergents

Gram Positive Bacteria: Susceptibility to anionic detergents is high in gram positive bacteria.

Gram Negative Bacteria: Susceptibility to anionic detergents is low in gram negative bacteria.

Inhibition by Basic Dyes

Gram Positive Bacteria: Inhibition by basic dyes is high in gram positive bacteria.

Gram Negative Bacteria: Inhibition by basic dyes is low in gram negative bacteria

Cell Wall Disruption by Lysozyme

Gram Positive Bacteria: The cell wall of the gram positive bacteria is more prone to disruption by lysozyme.

Gram Negative Bacteria: The cell wall of the gram negative bacteria is less prone to disruption by lysozyme.

Pathogenicity

Gram Positive Bacteria: A few types of pathogenic bacteria are to gram positive.

Gram Negative Bacteria: Most pathogenic bacteria are gram negative.

Toxins

Gram Positive Bacteria: Exotoxins are produced by gram positive bacteria.

Gram Negative Bacteria: Either endotoxins or exotoxins are produced by gram negative bacteria.

Gram Positive Bacteria: Gram positive bacteria are more susceptible to antibiotics like Penicillin and Sulfonamide.

Gram Negative Bacteria: Gram negative bacteria are more resistance to antibiotics. But, they are susceptible to Streptomycin, Chloramphenicol, and Tetracycline.

Examples

Gram Positive Bacteria: Lactobacillus, Actinomyces, Bacillus, Clostridium, Corynebacterium, Staphylococci, and Streptococci are examples for gram positive bacteria.

Gram Negative Bacteria: Acetobacter, Chlamydia, Borrelia, Bortadella, Burkholderia, Enterobacter, Escherichia, Helicobacter, Klebsiella and Neisseria are examples for gram negative bacteria.

Conclusion

Gram positive and gram negative are two differentiations found in bacteria, which can be used to classify bacteria. The differentiation is based on the thickness of the peptidoglycan layer, which is found in the cell wall. Peptidoglycan is found in both gram positive and gram negative bacteria. It provides mechanical support and the characteristic shape to the bacteria. Peptidoglycan layer of gram positive bacteria is multilayered. But, it is a monolayer in gram negative bacteria. Due to the thickness of the peptidoglycan layer, gram positive bacteria is capable of retaining the gram stain, crystal violet-Iodine complex, inside the cell wall. Hence, they can be visualized under the microscope in purple color. However, gram negative bacteria are unable to retain the gram stain and they can be stained by the counter stain safranin. On the other hand, gram negative bacteria contains an outer membrane, which gives the antibiotic resistance to the bacteria. Some bacteria like *Mycoplasma* species lack peptidoglycans in the cell wall and are unable to be distinguished as gram positive or gram negative. These species bear some membrane structures of both gram positive and gram negative bacteria. The main difference between gram positive and gram negative bacteria is the thickness of cell wall peptidoglycan layer present in each bacteria.

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About the Author: Lakna

Lakna, a graduate in Molecular Biology & Biochemistry, is a Molecular Biologist and has a broad and keen interest in the discovery of nature related things

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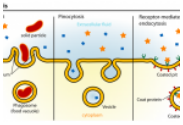

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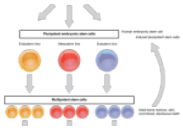

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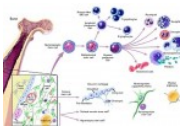

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