

Borellia burgdorferi--Fact Sheet

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Scientists believe that less than 10% of the bacteria species in the world have been identified. Roughly 99% of bacteria species cannot be grown in culture. It has been estimated that there are more microbes associated with the human body (about 10^{14} , or 100,000,000,000,000 bacterial cells) than there are human cells in it (about 10^{13}). And, our resident bacteria is extremely diverse--consisting of more than 400 different species or types of bacteria. A cubic inch of stool may contain several billion bacteria. Fortunately, most bacteria do not cause disease.

In 1981, the causative agent of Lyme disease, *Borellia burgdorferi*, was first identified. Bacteria are classified by shape, color (gram negative or gram positive), their use of oxygen, and, more recently, genome information. A description of *Borellia burgdorferi* (*Bb*) along these parameters follows:

Shape:

There are three shapes of bacteria:

- Round: Cocci, e.g., Pneumonococci
- Rod-like: Bacilli, e.g., Salmonella
- Spiral: Spirochete, e.g., Borrelia

Bb are spirochetes. Some bacteria have flagella, whip-like tails, that increase their mobility. *Bb* has 7-11 internal flagella or endoflagella that form a structure called an axial filament. The flagella attached at each end rotate in opposite directions, increasing and releasing tension. This provides the snake-like movement that allows *Bb* to bore through tissues easily.



Oxygen Use:

When bacteria first came in existence 3.8 billion years ago, the atmosphere had no oxygen. Oxygen was poison to these bacteria, which are called anaerobic. Oxygen appeared around 2.5 billion years ago and adaptation enabled some bacteria to survive. Today, most bacteria grow in the presence of oxygen and are called aerobes. Anaerobes tolerate only low levels of oxygen and thrive in intestines, deep wounds, and decaying tissues. *Bb* is an anaerobic bacteria, which can survive in areas where there are low levels of oxygen.

Color:

Bacteria are also classified by their color after a Gram stain is applied. Gram-positive bacteria stain blue, while gram-negative bacteria stain pink. *Bb* is gram negative, but it stains weakly. Gram-negative bacteria have a cell wall containing lipopolysaccharide (LPS), an endotoxin, which is released from the cell wall into the body when the bacteria dies. LPS has been found on other spirochetes, but its presence on *Bb* is debated. However, it is believed that two glycolipids identified on *Bb* may be functional equivalents of LPS.

Genome:

Bb contains approximately 1738 genes compared to 1039 genes on the bacteria that causes syphilis. Of 430 genes on 11 plasmids, most have no known function. The genomic sequence *Bb* identified 21 different plasmids-- these constitute 33% of *Bb*'s DNA and are the largest number of plasmids known in any bacteria. More than 90% of these plasmid genes are unique to *Bb* and do not exist in any other organisms. The genome revealed no obvious virulence factors, leaving many questions open.

Other Facts:

Bb is an obligate parasite with limited metabolic capability and cannot live without a host. It has none of the genes necessary for the synthesis of amino acids, fatty acids, lipids, or enzyme co-factors. This is why it must be cultured in a complex growth medium called BSK made with rabbit blood. *Bb* is a slow grower. The number of spirochetes doubles every 12-24 hours under optimal in vitro conditions. A recent study found that the mean time to culture skin biopsies was 25 days, with some cultures taking as long as 56 days.

Sources: *The Merck Manual* (www.merck.com/mmhe/sec17/ch190/190a.html); Laboratory of Human Bacterial Pathogenesis, Pathogen-Vector Molecular Interaction Section (www.niaid.nih.gov/dir/labs/lhbp/rosa.htm). USprobiotics.org @ www.usprobiotics.org. Coulter, P. et al, Two-year evaluation of *Borellia burgdorferi* culture and supplemental tests for definitive diagnosis of Lyme disease. (2005) *J Clin Micro* 43 (10): 5080.