Lyme borreliosis (Lyme Disease)
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**Symptoms**
The Centers for Disease Control and Prevention (CDC) warn of the following signs and symptoms in reference time of infection of Lyme Disease:

Early (9 to 30 days after bite):
- Fever, chills, swollen lymph nodes, headache, fatigue, muscle and joint aches
- Erythema migrans rash (in 70-80% of those infected)
- Begins at the site of the bite and may feel warm to the touch and/or create a bullseye pattern on the skin

Late (days to months after bite):
- Severe headache and/or neck stiffness
- Arthritis with severe joint pain and swelling, especially of the knees
- Short term memory issues and inflammation of the spinal cord and brain
- Dizziness or episodes of shortness of breath
- Facial palsy
- Heart palpitations or irregular heartbeat
- Nerve pain, including tingling or numbness in the hands or feet

**Mode of Infection**
The Lyme Disease bacterium is spread through the bite of infected ticks. Ticks can attach to any part of the human body and must be attached for 36 to 48 hours or more before the Lyme Disease bacterium can be transmitted (CDC). For Lyme Disease to exist in an area, three elements must be present in nature: the Lyme Disease bacteria, ticks that can transmit them, and mammals (such as mice and deer) to provide food for the ticks in their various life stages (Jacobs, 2013). According to the CDC, a person cannot get infected from touching, kissing, or having sex with a person who has Lyme Disease. Additionally, there is no credible evidence that Lyme Disease can be transmitted through air, food, water, or from the bites of mosquitoes, flies, fleas, or lice (CDC).

**Prognosis**
Without treatment, complications can develop in the joints, heart, and nervous system. If symptoms continue for a long period of time after a full course of antibiotics has been taken, then the disease becomes known as Post-Lyme Disease Syndrome (MedlinePlus).

**History**
Lyme Disease was diagnosed as a new condition for the first time in 1975 in Old Lyme, Connecticut. In 1977-78 it was discovered that the disease was caused by bacteria transmitted in the saliva of ticks, such as the blacklegged tick (Trechel, 1983). In 1982, Willy Burgdorfer found that spirochetes were responsible for causing Lyme disease, which is known as Borrelia burgdorferi (Bay Area Lyme Foundation).

**Pathogen Characteristics**
A study conducted by Brisson et al. describes the overall structure and genetics of the Borrelia burgdorferi bacterium. Belonging to the phylum of bacteria called spirochetes, these bacteria are characterized by their long, thin, corkscrew-like structure. The study discusses how Borrelia species are the only species within their phylum to require an arthropod vector in order to be transmitted into vertebrate hosts. Additionally, a study done by Fraser et al. regarding the genomic sequencing of the bacterium describes the genome as containing a linear chromosome of 940,725 base pairs and possibly more than 27 linear and circular plasmids that combine to a size of more than 533,000 base pairs. From this study, it is also found that the chromosome contains 853 genes which encode a set of proteins for DNA replication, transcription, translation, metabolism, and solute transportation, but contains no gene which codes for biosynthetic reactions. In Biosynthetic reactions monomers can be put together to form macromolecules (Fraser et al., 1995).

**Relevance to Coursework**
Cell Signaling:
Different immune systems will respond differently, which can be explained by the productivity of cytokines, which are cell signaling molecules that aid cell to cell communication in immune responses and stimulate the movement of cells towards sites of inflammation, infection and trauma. These are the most important signaling molecule in our immune system (Redbud University, 2016).

Oxidative Phosphorylation:
Borrelia burgdorferi does not perform oxidative phosphorylation, which means the bacteria produces energy through substrate level phosphorylation during fermentation. It does this because it lacks genes homologous to the encoding proteins involved in oxidative phosphorylation (McFarland et al., 2010).

**References**


**Climate Change**
Current Work in the Field
Climate Change:
Cases of Lyme disease are highly concentrated in the northeastern United States, spreading north to Canada and south to Virginia (Lavelle, 2014). According to the CDC, an accepted reason for the increase in Lyme disease cases, seen on the graph below made by the Environmental Protection Agency (EPA), is the growth of suitable habitat for the blacklegged tick. The CDC believes that climate change may be a factor of this, and the EPA added Lyme disease to its list of climate change indicators during Spring 2012. Basically, as temperature rises for an extended period of time, tick populations are active earlier in the year, and the risk of human infection increases.

**Vaccine Development**
There is currently no active vaccine for Lyme disease in humans (CDC). In 1998, the FDA approved a Lyme disease vaccine, LYMErix, which reduced new infections in vaccinated adults by nearly 80% (Nigrovic et al., 2007). In 2002, the manufacturer voluntarily withdrew its product from the market citing uncertainty about the risk of disease and low public demand (La Vigne et al., 2012). The study notes that Biotech firm Valneva will begin phase I human trials for a new Lyme disease vaccine in the U.S. and Belgium on 280 patients aged 18 to 40 years in a single-blind, partially randomized, dose escalation study. Valneva's vaccine aims to target six different strains of outer surface protein A (OspA), one of the most dominant antigens expressed by the Borrelia bacteria transmitted by a tick, and teach the body's immune system to recognize the bacteria and launch an attack (La Vigne et al., 2012).