Mellisa Clemons
Section 06
Final Draft

Neisseria meningitidis

Neisseria meningitidis, or meningococcus (MC), belong to the Beta Proteobacteria class. The MC are Gram-negative, encapsulated and non-motile. They are diplococci in structure and have a half kidney bean shape. Humans are the only host for the meningococcus. *Neisseria meningitidis* commonly resides in the nasopharynx in approximately 5% of humans in a normal setting and as high as 40% of humans living in close quarters such as military camps and universities. (Jolley, et. al., 2004) There are 13 different serogroups (strains) of *N. meningitidis* with only five (A, B, C, Y and W-135) that are the most common in causing disease states.

The habitat for *N. meningitidis* doesn't undergo a wide range of temperature and environmental changes. *N. meningitidis* cannot survive in temperatures lower than 30 degrees Celsius. *N. meningitidis* spreads from host to host through respiratory droplets from coughing, sneezing, etc. To inhabit a host, the MC must first attach itself to a non-ciliated columnar epithelial cell using its type IV pili. Often MC will "colonize the nasopharyngeal mucosa without affecting the host, a phenomenon known as carriage." (Yazdankhah, et. al., 2004) After colonizing in the nose or throat, it can then spread to the blood stream and the cerebral spinal fluid (CSF) of the human host, causing bacterial meningitis. Initial symptoms of the bacterial meningitis include headache, fever, and a stiff neck. Without the help of antibiotics severe complications can occur include hearing loss, memory loss, brain damage, coordination problems, kidney failure, seizures and even death.

Like most bacterium, N. meningitidis requires forms of iron as an energy source for replication by binary fission. Replication is done by acquiring the required form of iron from the host as energy and using it in processes such as transcription and electron transport. (Larson, et. al., 2002)

N. meningitidis uses different forms of iron as a type of niche indicator inside the host. There are different sources of iron available in the human body. "During different stages of colonization and infection available iron sources differ, particularly the host iron-binding proteins haemoglobin (Hb), transferrin (Tf), and lactoferrin (Lf)." (Jordan and Saunders. 2009) The gene expression of MC has been shown to change depending on the niche and therefore iron source that is available to be consumed. *N. meningitidis* uses mainly Lf in the first stage of attachment to endothelium in the mucosal linings, followed by Hb after it invades the vascular system, and finally Tf in the CSF.

On a biotic level, MC has adapted to be able to interact with other species of bacterium to acquire its iron needs. When the human host detects the presence of a potential pathogen it limits the amount of free iron available for use in the body. Most other bacteria secrete siderophores that complex iron. (Jordan and Saunders. 2009) *N. meningitidis* does not produce siderophores. Instead MC uses surface receptors that bind to host proteins that contain iron. *N. meningitidis* are also able to utilize siderophores from other commensal bacteria (Jordan and Saunders. 2009) in a competitive interaction.

N. meningitidis could also be adapting through "horizontal gene transfer" during the carrier state. (Yazdankhah, et. al., 2004) "Due to the wide variety of different bacteria present in the human nasopharynx and the length of time present there can be gene transfer between even

phylogenetically distant species. This may lead to rapid evolution of the meningococcal genome." (Yazdankhah, et. al., 2004)

Genetic variation could also be due to natural selection. Selective forces such as the genetic resistance to a host's immunity genotype and transmission strategies could lead to certain serogroups being carried through specific human hosts. Each serogroup then specializes in the colonization of each host group. (Jolley, et. al., 2004) This could be in part responsible for the coming and going of epidemics in a given area. A new genetic variety that is more suitable for the host population can sweep through a population rather quickly until the population develops an immunity from prior exposure to the *N. meningitidis*.

Like other bacteria, *N. meningitidis* has shown a resistance to antibiotics. "The first strain with some degree of penicillin resistance was detected in Spain in 1985." (Latorre, et. al., 2000) One of the serogroups studied was a cluster of serogroup C. A phenotype from this serogroup was found to be a mutant from an earlier epidemic strain and showed high penicillin-resistance rates. "Overall resistance rates ranged from 9.1% in 1986 to 71.4% in 1997." (Latorre, et. al., 2000) The ongoing evolution of *N. meningitidis* to many antibiotics can also be tied to horizontal gene transfer mentioned earlier.

There have been many vaccines that have been developed recently to assist the hosts in immunity to *N. meningitidis*. Although due to some surface antigens present on some serogroups some vaccines are currently lacking in full protection. (Yazdankhah, et. al., 2004) The end result ends up being an infected host that, if they survive the infection, could still suffer permanent disabilities for the remainder of their life. *Neisseria meningitidis* has successfully adapted and evolved overtime.

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