Introduction
The surge of antibiotic-resistant bacteria has raised substantial concerns over how to effectively and efficiently control antibiotic-resistant bacteria capable of secreting biofilms. A biofilm can be defined as a self-producing extracellular matrix (Carter, et al., 2016). Manuka honey, an alternative to conventional antibiotics, has proven successful in inhibiting planktonic cells and killing bacteria living under the protection of biofilms (Brudzynski & Sjaarda, 2015).

Formation of Biofilms
When the structures and functions of various biofilms were assessed, their mechanisms of resistance appeared to be dependent upon multicellular strategies. First, the higher the number of cells present in a given area increases the resistance of these cells to antibacterial activity (Carter, et al., 2016). Therefore, antibacterial activity of Manuka honey has to be tested individually.

The Origins of Manuka Honey
Manuka honey is produced by select Leptospermum species native to New Zealand and Australia, and is colonized by the honey bees, Apis mellifera (Brudzynski & Sjaarda, 2015). Levels of antimicrobial components contained in different batches of Manuka honey can range from 100ppm to greater than 1200ppm (Carter, et al., 2016). Therefore, antibacterial activity of Manuka honey has to be tested individually.

Medical-grade Manuka honey is subjected to gamma radiation in order to ensure its sterility (Carter, et al., 2016). The medical community developed the phenol scale as a standard to express the potency of antibacterial activity.

Anti-Microbial Properties of Manuka Honey
Methylglyoxal: Unique Manuka Factor (UMF)
In biofilms containing persisting cells, requiring minimal amounts of energy in order to survive for long durations (Cundell & Wilkinson, n.d.). Therefore, as the surface level cells die, they offer a protective layer of impenetrability for persisting cells in the center of the biofilms (Cundell & Wilkinson, n.d.). Finally, in order for biofilms to be present, an initial adherence to a physical material is required. (Lin, et al., 2010).

Anti-Biofilm Activity in Manuka Honey in Combination with Antibiotics
Manuka honey has been proven to inhibit in-vitro antibiofilm experiments. More specifically, Gentamicin and Manuka honey produced an additive interaction against P. aeruginosa biofilms and a synergistic interaction with vancomycin against S. aureus biofilms (Campeau & Patel, 2014). When Manuka honey dressings were utilized in conjunction with oxacillin, tetracycline, imipenem, and mupirocin, a synergistic effect was achieved against MRSA (Carter, et al., 2016). The findings suggested that the combined therapeutic intervention of Manuka honey wound dressings and antimicrobials could lower the dosage of antimicrobial medications required to inhibit the biofilm as well as prevent the development of resistance.

Gastrointestinal Ulcers
Almasaudi et al. (2016) has performed experiments to assess gastroprotective effects associated with Manuka honey against ethanol-induced gastric ulcers in rats. After experimentation, the researchers were able to conclude that Manuka honey substantially lowered the rats’ ulcer index, indicating that it protected the gastric mucosa from lesions and preserved gastric mucosal glycoproteins. Further research and experimentation is still needed in order to determine if Manuka honey is able to produce similar anti-ulcer outcomes in humans.

Anti-Cancerous Properties
Vallianou, Angelopoulou, Skourtis, and Kazazi (2017) have performed in-vitro experimentation, the anti-cancerous properties of Manuka honey via apoptosis. Scientists believe that Manuka honey induces caspase-9, which in turn, activates the caspase-3 executor proteins. These caspase enzymes are directly involved in the death receptor signaling pathway, which ultimately induces apoptosis (Vallianou, et al., 2017). This contributes to the immune-protective and immune-modulatory activity, which is closely associated with anti-cancerous properties. In vivo testing has yet to be conducted. Therefore, Manuka honey’s interaction in the human body is unknown and may inhibit or alter some of the anti-cancerous properties observed.

References
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Further Applications
Gastrointestinal Ulcers
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