Synthesis of Multivalent Glyco-Magnetic Nanoparticles for Rapid Point-of-Care Diagnostic System

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Title – Synthesis of Multivalent Glyco-Magnetic Nanoparticles for Rapid Point-of-Care Diagnostics System – Synthesis of carbohydrate conjugated magnetic nanoparticles

A Proposal for the Research and Creative Experience for Undergraduates (RCEU) Program, Summer 2018

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Project Summary

Detection of a bacterial infection relies heavily on antiquated microscopy methods and colony morphology. Most of these detection techniques require laborious microscopy methods and/or bacterial culture (e.g.: Bacterial culture of *M. tuberculosis* bacteria takes approximately three weeks). Rapid diagnosis is key to contain highly infectious diseases such as tuberculosis. The proposal uses a novel set of carbohydrate functionalized nanoparticles to specifically bind to bacteria and which would ease visualization of one bacterial species over colonies of different species. These novel carbohydrate functionalized magnetic nanoparticles (glycoMNPs) interact and cross link specific bacteria strains precipitating them from solution within minutes. At lower concentration agglomerated bacteria can be drawn towards an externally placed magnet and at higher concentration they can be visualized by the naked eye.

Research Plan

I. Synthesis magnetic nanoparticles (MNPs) – Iron oxide based superparamagnetic nanoparticles (SPIONs) would be prepared using wet chemical synthesis as reported in literature.

II. Carbohydrate functionalizing of MNPs – Surface of MNPs would be functionalized using already synthesized phosphate modified trehalose and mannose saccharides to produce glycoMNPs

III. Purification – Synthesized particles would be purified using repeated high-speed centrifugation and collected particles would be concentrated in a compatible solvent.

IV. Characterization – Functionalized MNPs would be characterized using Fourier transform –infra red (FT-IR) spectroscopy and dynamic light scattering.

V. Application – Interaction of glycoMNPs with bacteria *Mycobacterium smegmatis*, *Escherichia coli* and *Streptococcus aureus* could be visualized using optical microscopy, with an external magnet which can direct the motion of bacteria in solution.
**Student Duties** – Synthesis, functionalization and purification glycoMNPs. Looking at the interaction of glycoMNPs with bacteria.

**Tentative Time Line**

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**Manuscript/Poster Preparation** – Participating student would be strongly encouraged to write up their research project results in the format of Journal of American Chemical Society (JACS) or least have the results in form of a poster presentation for ACS regional meeting. A successful project would be strongly considered for publication with additional data where the student could be a co-author or combined first author along with a graduate student of the group.

**Expected Student Background** – Students should have strong background in General Chemistry. Fundamental knowledge of Inorganic Chemistry is an advantage. Student major in Chemistry, and or Chemical Engineering would be benefited.

**Expected results and deliverables** – Participating student would be exposed to state-of-art nanomaterial synthesis and characterization in a real world application. Students would be exposed to simple synthesis of small molecules and bio conjugation chemistry. Students would be encouraged to maintain standard laboratory notebooks and would be exposed to good laboratory practices. They would be expected do a scientific presentation each week and hence be exposed to a peer review setting where their work would be critically analyzed.

**Faculty Supervision and Mentoring** – Dr. Jayawardena will supervise all the steps in nanoparticle preparation and application. Including final manuscript preparation. Group meeting would be held weekly where the student will present his/her progress or problems of the project with the entire group. The student will have access to the instructor at least once a day.