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Quantum Dots as a Tool for Rapid Point-of-Care Diagnostics of Clamydia

Surangi Jayawardena
University of Alabama in Huntsville

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Surangi Jayawardena, Assistant Professor, Department of Chemistry

MSB 305, 256-824-5445; E-mail: hj0022@uah.edu

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Project Description

Chlamydia is a common sexually transmitted infections (STI) caused by infection from the pathogenic bacteria *Chlamydia trachomatis,* an obligate intracellular parasite.[1] It is the most prevalent of all STIs. In 2016, there have been approximately 1.6 million documented cases of Chlamydia in the US, a 4.5% increase compared to 2015, and the STI testing market is shown to grow upto US $ 167 billion by 2020. Most often Chlamydia is asymptomatic, but left untreated can lead to serious consequences. In women, it leads to pelvic inflammatory disease (PID), infertility, ectopic pregnancy (pregnancy outside the uterus); in men it leads to urethritis (inflammation of urethra). Quantum dots functionalized with antibodies would be used to bind to the cell surface of *Chlamydia trachomatis*. Multivalency in binding of the functionalized quantum dots (QDs) affords cross-linking between bacteria to form fluorescent aggregates that could be detected using a pen laser.[2,3]

Student Duties, Contributions and Outcomes

I. Synthesis of quantum dots – Water-soluble hydrophilic (CdTe) and hydrophobic (CdSe) QDs. (1-8 weeks)

II. Surface functionalization with monoclonal antibodies - Surface of QDs would be modified with a silica coating to create a silica coated QD (SQD), and then surface would be functionalized with protein (mAb-SQDs). (3-8 weeks)

III. Purification & Characterization– Synthesized particles would be purified using repeated high-speed centrifugation and collected particles would be concentrated in a compatible solvent. Characterization – Functionalized mAb-SQDs would be characterized using Fourier transform –infra red (FT-IR) spectroscopy, fluorescence spectroscopy, dynamic light scattering. (6-8 weeks)

IV. Application – Interaction of mAb-SQDs with bacteria *Chlamydia trachomatis* (8-10 weeks)

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.

Faculty Requirement and Mentorship

Expected Student Background – Students should have strong background in General Chemistry. Fundamental knowledge of Organic Chemistry is a definite advantage. Student major in Chemistry, Biology, 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.

Prior Awardees

RCEU 2018 - Quantification of the Limit of Detection of Pathogenic Bacteria Using a Glyconanomaterial Based Rapid Point-of-Care Diagnostics System – James Johnson

RCEU 2018 - Functionalized Nanomaterial as a Tool for Rapid Point-of-Care Diagnostics – Melinda Mustain

RCEU 2018 - Synthesis of Multivalent Glyco-Magnetic Nanoparticles for Rapid Point-of-Care Diagnostics System – Veer Devarasetty

Student contribution: all students work surmounted to a provisional patent submitted by UAH, data for two SERMACS poster presentations, *manuscript in preparation* Rapid Point-of-Care Diagnostic of Mycobacteria using Multi-Core Shell Magnetic Silica Nanoparticles

References

(1) Elwell, C.; Mirrashidi, K.; Engel, J. Chlamydia cell biology and pathogenesis. *Nat. Rev. Microbiol.* **2016**, *14*, 385-400.

(2) Chen, X.; Wu, B.; Jayawardana, K. W.; Hao, N.; Jayawardena, H. S. N.; Langer, R.; Jaklenec, A.; Yan, M. Magnetic Multivalent Trehalose Glycopolymer Nanoparticles for the Detection of Mycobacteria. *Advanced Healthcare Materials* **2016**, *5*, 2007-2012.

(3) Jayawardana, K. W.; Jayawardena, H. S. N.; Wijesundera, S. A.; De Zoysa, T.; Sundhoro, M.; Yan, M. Selective targeting of Mycobacterium

smegmatis with trehalose-functionalized nanoparticles. *Chem. Commun.* **2015**, *51*, 12028-12031.