1. **Project Title: Using Engineered Proteins in Diagnostic Tests to Combat Antimicrobial Resistance**

**MIT Faculty Advisor:** Hadley SIKES  
**Mentor:** Patthara KONGSUPHOL  
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**Overview:** Antimicrobial resistance (AMR) has gained significant concerns locally and globally. It is predicted that by 2050, fatality caused by AMR will surpass that of cancer. Antimicrobials are often prescribed before infections have been properly diagnosed. This significantly contributes to rapid development of AMR. Accurate diagnostic tools for detection of bacterial and viral infections are highly desired to help limit the development of AMR.

Certain set of biomarkers are currently used in clinical settings to distinguish bacterial from viral infections. However, they are far from providing absolute answers to clinicians. Rapid diagnostic kits for detection of these markers exist however many lack sensitivity and specificity. False positives and false negatives are often reported from these kits.

To minimize the incidence of false positives and false negatives as well as to obtain high accuracy detection of the biomarkers, in this study, ultra-high, aM to fM, sensitivity assays (aM to fM) will be developed. Engineered protein will be generated to replace antibodies. The proteins will be used for rapid paper-based assays and also for single molecule array tests (Quanterix Simoa platform). To improve detection accuracy of bacterial vs viral infections, expanded panel of biomarkers will be thoroughly searched from the literatures and these markers will be tested using the newly engineered proteins for high sensitivity signal detection.

Once the engineered antibodies and the panel of biomarkers have been optimized, clinical samples will be tested in the next phase of the study. Finally rapid and simple-to-use diagnostic kits will be developed to accurately distinguish bacterial from vital infections.

**Qualifications/Skills:** Strong background in immunoassay e.g. ELISA
Research Projects in the SMART AMR IRG  
(October 31, 2018)

**Goals:**
- To characterize the kinetic properties of the newly engineered proteins in solution phase and when immobilize on porous media.
- To develop high sensitivity assay using single bead-based molecule array tests (Quanterix Simoa platform).

**References:** *NIL*

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2. **Project Title:** Recovery of Bacteria from Complex Biofluids using Microfluidics Cell Separation Devices

**MIT Faculty Advisor:** Jongyoon HAN  
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**Overview:** Bloodstream infection (BSI) such as bacteremia or sepsis has been known to be a major cause of mortality worldwide. In managing BSI, rapid detection method of blood-borne bacteria is a high priority because earlier diagnosis results in reduced BSI-related morbidity or mortality. Isolation and identification of bacteria from bacteria-infected blood are often hindered by extremely low abundance (~1-5 CFU/ml) and presence of large molecular and cellular backgrounds, so bacterial diagnosis has been mainly dependent upon blood culture followed by phenotypic assay. However, culture analysis takes a long time (> 48h) during which indiscriminate use of broad-spectrum antibiotics lead to increased antibiotic resistance and collateral damage to normal gut fauna with adverse effects. Rapid assays to detect pathogen directly from blood have been reported, but these assays have limited sensitivity and specificity due to host contamination, and can only target a limited panel of pathogens, so they have yet to be successful in changing clinical practice. We would like to address this problem by proposing a rapid, culture-free workflow for identification of a wide range of bacteria from blood with very low abundance of bacteria, which is made possible by use of our spiral microfluidic sorter.

**Qualifications/Skills:** Willingness to learn hands-on experiments; appreciation of hardware-based engineering (microfluidics); patience to handle typical experiment-related frustration (a.k.a. failure).

**Goals:** We will be separating pathogens from various complex biofluids (pus, blood, sputum, etc.) which are characterized by many host cells and other background materials, which prevent many different downstream assays. Working with Singaporean collaborators, we will be isolate pathogens in animal wound fluid / pus to further analyze the pathogens found, to gain scientific insights. You will be helping the team by carrying out sample preparation for these complex biofluid.
Research Projects in the SMART AMR IRG  
(October 31, 2018)

References: