**The Chinese University of Hong Kong**
**Department of Biomedical Engineering**

# Graduate Seminar – PhD Oral Defence

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| ***Student*** | ***:*** | Ms. HUANG Ting |
| ***Supervisor*** | ***:*** | Prof. GAO Zhaoli |
| ***Date*** | ***:*** | 12 November 2024 |
| ***Time*** | ***:*** | 3:00 pm |
| ***Venue*** | ***:*** | Room 1122, William M W Mong Engineering Building, CUHK |

**Title: Functionalized Graphene Field-effect Transistors for High-sensitivity Biomarker Detection**

With the increasing incidence of cancer worldwide, early diagnosis and effective treatment of cancer have become particularly critical. Small noncoding microRNAs (miRNAs) have been widely used as the biomarkers in cancer diagnosis due to their specific association with disease occurrence. Molecular diagnostic techniques, especially nucleic acid analysis, play a crucial role in improving the early detection rate. However, traditional nucleic acid detection methods are often costly, labor-intensive, and require bulky instruments. A graphene field-effect transistor, functionalized with biological probe molecules, is capable of detecting target molecules, such as oligonucleotides, through the chemical gating effect, offering high sensitivity with the advantages of cost-effectiveness and label-free detection.

This research explored the Chemical Vapor Deposition of high-quality monolayer graphene and fabricated the GFETs via scalable photolithography process. To demonstrate the versatility of GFETs, we functionalized the GFET surface with ionophore, creating a graphene-based ion-selective FET biosensor (G-ISFET). This G-ISFET exhibited high sensitivity and selectivity for sodium sensing and demonstrates real-time monitoring capabilities. After the first attempt, we then focused on the nucleic acid detection. To overcome the binding-affinity dependent limit of detection, we designed an exponential target recycling hybridization chain reaction (Exp_TRHCR), enabling rapid and sensitive detection of miRNA-2l with a LOD of ~ 100 aM, within a significantly reduced time frame by 30-fold, specifically from 15 hours down to 30 minutes, with the assistance of Exp_TRHCR. This work established a rapid and accurate biosensing platform capable of detecting trace amounts of nucleic acid biomarkers, thereby holding significant potential for a wide range of clinical applications at the point of care. Finally, considering the molecular heterogeneity characteristic of cancer cells, there is a great need for multiplex detection of miRNAs. To address this concern, we then designed and investigated the DNA-based Boolean logic gates GFETs. The logic gate complex enables the transformation of two short target miRNAs into output chain S, overcoming the binding-affinity dependent limitations and achieving a detection limit of approximately 1 fM.

***** ALL ARE WELCOME *****

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