PROFESSOR MATT TRAU

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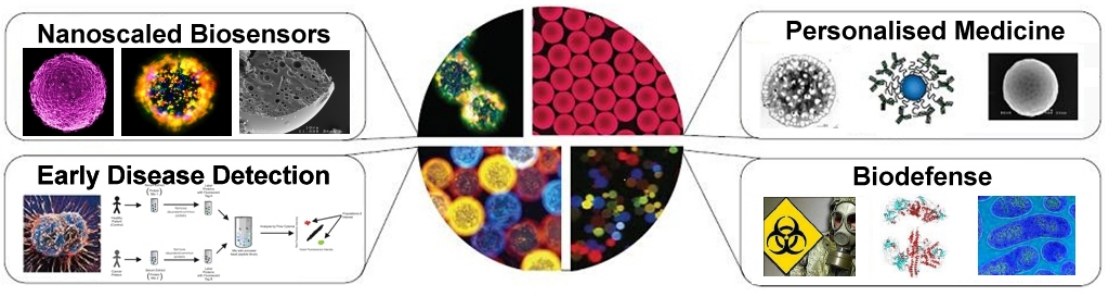
Our group focuses on using innovative chemistry to produce nanoscaled materials and devices with applications in biology, biotechnology and medicine. Our Centre for Biomarker Research and Development is located on the 5th floor of the Australian Institute for Bioengineering and Nanotechnology (AIBN) and has access to state-of-the-art chemistry synthesis and characterisation facilities. Honours students working in these areas will have the opportunity to create nanoscaled biosensor devices for applications in cancer, infectious disease, novel therapeutics, biosecurity and point-of-care devices. Students will also be given the opportunity to work with leading geneticists, epigeneticists and clinical researchers in order to test constructed devices in a real world setting.
Current projects available include:

Detecting Disease Biomarkers and Pathogens with Nanotechnology

Diagnostic devices that detect diseases such as cancer at an early stage, when the disease is most responsive to contemporary therapies, provide the greatest social and economic benefits to society. Unfortunately, current diagnostic protocols typically depend on a complicated variety of tests based on a wide range of different, and often expensive, technological platforms. Each different platform requires significant investment in single-use equipment and training. Despite this investment, results can be ambiguous and require multiple, different tests to produce a confirmed result for a single pathogen. Nanotechnology offers the promise of miniaturized, inexpensive, flexible and robust **"plug-and-play" molecular reading systems** which can be effectively deployed in the field.

In this project, students will develop novel biosensor systems which may be used to greatly aid the detection of genetic, epigenetic and proteomic biomarkers for applications in early disease diagnosis, personalised medicine or biodefense.



Schematic of nanoscaled biosensors for early disease detection, personalised medicine and biodefense.

PROFESSOR MATT TRAU & DR MUHAMMAD SHIDDIKY

1) Microfluidic Devices for Capturing Rare Circulating Tumour Cells

As cancer mortality rates continue to rise, the national impact of the cancers is beginning to overwhelm healthcare services. The progression of cancer in patients is characterized by cells that invade locally and metastasize to nearby tissues or travel through the blood stream to set up colonies in the other parts of the body. These cells, accounting for 1 or fewer cells in 10^5 – 10^6 peripheral blood mononuclear cells, are known as circulating tumour cells (CTCs). Development of advanced technology for capturing CTCs in blood in the early stage of the metastasis process would be transformative in the treatment of cancer. This project strives to build and test a microfluidic device

with the capacity to enable selective capture and sensitive detection of CTCs by incorporating three-dimensional microstructured electrodes within the detection/capture domain of the device.

2) Nanodevices/Nanobiosensors for Cancer Biomarker Proteins

The clinical use of immunoassays in treatment of cancer at early stages of the disease requires detection of proteins of typically 10^{-16} to 10^{-12} M concentration in whole blood, blood plasma or serum samples. Detecting this low concentration of proteins is potentially useful for identifying individuals at risk and for clinicians to prescribe preventive measures for these individuals. Current immunoassay technologies typically measure the proteins at concentration above 10^{-12} M. The development of a detection method that is rapid, cheap, and more sensitive than those currently available could revolutionize many medical treatments in areas such as cancer. In this project, we aim to fabricate nanobiosensors with nanostructured 3D-electrodes to detect single protein molecules in blood.

Via these projects, students will achieve hands on experience in the design, fabrication and application of the microfluidic devices and electrochemical micro(nano)biosensors.

PROFESSOR MATT TRAU

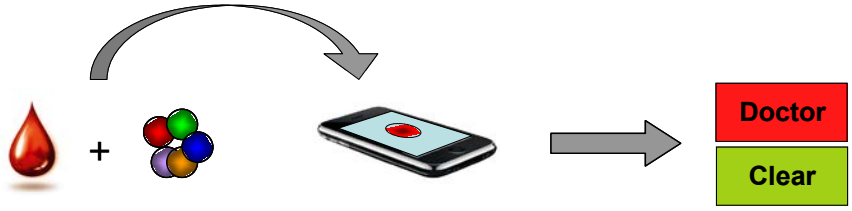
1) DNA Nanomachinery for Early Breast Cancer Detection

Every 3 minutes a woman is diagnosed with breast cancer. Despite the increasing incidence of breast cancer in the Western world, death rates have been decreasing since 1990. This is the result of treatment advances, increased awareness and early detection. It is widely accepted that early detection results in much higher survival rates, but it is proving difficult to detect the cancer in its early stages. Subsets of RNA that are not translated into proteins have recently been identified in cancerous growths. These non-coding (*nc*) RNAs serve as potential biomarkers of disease. Our group is designing, developing and evaluating novel DNA nanomachinery to perform tasks that are currently beyond the reach of existing molecular readout technologies. We aim to use these nanomachines as a new technology platform to rapidly detect *nc*RNA biomarkers in breast cancer patients.

This interdisciplinary project combines the latest developments in molecular genetics with cutting edge nanobiotechnology and will provide an opportunity for students to acquire diverse skills in chemistry, molecular biology and bioengineering.

2) Point-of-Care Diagnostics

Point-of-care (POC) diagnostics have the potential to revolutionise global health care by enabling diseases to be rapidly diagnosed ‘on the spot’ using assays that require minimal specialised infrastructure. The simplicity of POC assays enables them to be performed by health care workers or even the patient, which enables rapid diagnosis of a disease. This improves the time taken to treat a disease, leading to better patient care and a reduced rate of mortality and morbidity. POC devices need to be practical, cost effective and portable with high sensitivity and specificity if they are to be used in resource limited settings.



Within our Centre we have an ongoing research program focused on designing and building simple (nanotechnology-based) molecular assays to generate new POC diagnostic technologies. This Honours project will be involved in designing, developing and evaluating novel methods to rapidly amplify and ultimately detect pathogenic DNA and RNA using everyday devices such as mobile telephones.

This interdisciplinary project combines the latest developments in biological chemistry with cutting edge nanobiotechnology and will provide an opportunity to acquire diverse skills in chemistry, molecular biology, bioengineering, and biotechnology.