Nano-biosensors for the early diagnostics of diseases

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Venue: Nelson Mandela African Institution of Science and Technology (NMAIST)

Facilitators;

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Purpose of the workshop:

Nanoscale Biophysics is a relatively recent discipline which applies fundamental principles of Physics to study the complexity of living systems at the molecular level. The rapid development in the field has made available a new range of tools and approaches that have revolutionized biological and medical research, by allowing scientist to manipulate nanoparticles and macromolecular objects, to monitor the interactions of single molecules in complex media and/or cell-cell interaction mechanics in health and disease.

The aim of the workshop is to introduce young researchers from different background as Physics, Nanotechnology, biological or medical sciences to the latest developments in the field of nanoscale Biophysics and in particular to novel technologies for the sensitive, low-cost, early diagnostics of molecular biomarkers of wide spread/neglected diseases. Also cell biomechanics as a tool for tissue nano-histology will be discussed.

The expectation is that this workshop will help to create a shared “language” and to forge links between participants through collaborative work with the AMRS network. Also, we expect that upon returning to their home institutions participants can potentially use the results of the techniques they learned to ensure that their communities are not “left behind” by this rapidly advancing field.

Outline

Introduction to Nano-biosensors

Non-invasive, precise diagnostics requires the parallel readout of different molecular biomarkers from nanoliter body fluids, as blood. Ordered assembling of molecular binders and miniaturization are fundamental key words in this field. After having defined what is intended for a biosensor, as well as the order of magnitude of biomarkers circulating in blood to be quantified in early disease development, participants will be introduced to advanced techniques for surface bio-functionalization and molecular manipulation (e.g. self-assembled monolayers; micro contact printing; Atomic Force Microscopy (AFM)) to create RNA/protein nano-arrays with mechanical readout.

Electrical readout based devices

In order to develop low-cost devices fully integrable with advanced microfluidic strategies, electrical readout is desired. Participants will be introduced to different strategies, as label-free electrochemical impedance spectroscopy, a non-faradaic electrochemical technique which holds the potential of fast, dynamic measurements.

Other label-free readout methods: vibrational spectroscopies; surface plasmon resonance

Alternative, optical readout methods will be discussed. Also, examples of nanoparticles-based sensors for the colorimetric detection of enzymatic reactions will be given.

Bio-indentation histology

Cell-cell and cell-extra cellular matrix interactions imply the activation of a biomechanical signals transmission chain. By using the tip of the AFM cantilever to probe the stiffness of a histological tissue with subcellular resolution, we can assess the presence and progression of diseases as cancer.

Discussion on Nano-biosensors for Africa

Participants will propose ideas on how they think nano-biosensors can be used to address Africa's challenges, especially in the context of the detection of neglected diseases. Also, it is expected that plans for establishing a collaborative network in the field through the AMRS contacts will be discussed.

Table 1 Time table for the nanobiosensors workshop

Time	Activity
0800-0830	Introductions and purpose of the workshop
0830-1030	Introduction to Nano-biosensors
1030-1100	Break
1100-1230	Electrical readout based devices
1230-1330	Lunch
1330-1430	Other label-free readout methods
1430-1530	Nano-mechanical Histology
1530-1600	Break
1600-1700	Discussion on Nano-biosensors for Africa