Temporally and spatially-resolved microproteomics and MALDI MSI lipidomic analysis for traumatic brain injury biomarker identification

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The major cause of traumatic brain injury (TBI) is the direct mechanical damage to brain tissue leading to an axonal disruption and wide spread neural dysfunction. In a possible therapeutic approach searching for injury related proteins, several studies identified TBI protein biomarkers such as GFAP and αII-spectrin. However, these studies used complete brain tissue as well as biofluids (serum/CSF/...). We investigated TBI impact at the injury site and surrounding tissues, in order to connect TBI microenvironment dynamics with the underlying biological processes. Using an experimental TBI rat model of mild/moderate controlled cortical impact (CCI) injury, we combined large scale proteomics identification and relative quantification using spatially-resolved microproteomics along with lipid MALDI MS imaging. Direct on-tissue micro-digestion followed by microextraction from 0.25 to 1 mm^2 surface area was subjected to an LC–MS and MS/MS analysis using HR MS. Meanwhile, our lipid imaging has revealed lesion-specific m/z in low mass range (<600 m/z). Our study is designed in a spatial (considering different regions of the brain) and temporal (1, 3, 7, and 10 days post injury) manner, in order to monitor possible affected brain regions (along with the injured cortical tissue) and characterize the underlying mechanisms occurring in time course post trauma.

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Nanotechnology for the control of parasitic and vector-borne diseases

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Nanotechnology is one of the new frontiers of biotechnology. Among metal and metal oxide nanomaterials, gold (Au NPs) and silver (Ag NPs) nanoparticles reveal a high interest for research in biomedical fields, the so-called nanomedicine, due to their outstanding physical and chemical properties. Very recently, nanomaterials have been introduced also in parasitology and entomology. Several applications have been developed with a wide spectrum ranging from detection techniques to drug development. In particular, Au NPs have been studied for their toxic effects against either protozoa or helminths. Furthermore, Au NPs, Ag NPs as well as metal oxide nanoparticles (e.g., ZnO and TiO_2) prepared using various "green" fabrication routes relying on cheap plant extracts or selected metabolites, have been tested as pesticides against a rather wide spectrum of arthropod vectors, with special reference to mosquitoes and ticks. These nanoformulated pesticides showed high toxicity against mosquitoes, such as the vectors of malaria, filariasis, dengue and Zika virus, as well as against ticks.

Ecotoxicology research, including genotoxicity studies, showed moderate to little nanoparticle toxicity towards several non-target organisms. Overall, the green synthesis technology represents an environment friendly approach, not requiring high energy inputs or hazardous substances, to effectively manage parasitic and vector-borne diseases.

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Smart tourniquet systems for military and civilian applications

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The tourniquet is a medical device in which a band of 4–7 cm in width is compressed and applied to the proximal part of the limb where the person has lost of excessive blood after extremity injury. Although the application of tourniquet seems to be simple, the correct application of tourniquet provides a significant contribution to the life. If the tourniquet is not tightened enough to stop blood flow, the blood loss will continue, and the injured life will be under the risk. On the other hand, if excessive pressure is applied and not loosened and tightened in a certain period, the application will cause gangrene at wounded extremity. Military personnel losses resulting in warfare injuries are approximately 50% of total losses. There are Combat Application Tourniquet (CAT) and Special Operations Forces Tactical Tourniquet (SOFTT), Emergency & Military Tourniquet (EMT) tourniquets, which are produced worldwide. However, there is no tourniquet system which is applied quickly with one hand, stops bleeding and transmits the position information of the injured person to a centre. The recent smart tourniquet systems with above features developed by our research team can be applied automatically by both pneumatic and mechanical methods.

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Building on biomimetics: Nanotechnology and novel medical devices

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The field of nanobiotechnology underlies the development of many novel biomedical devices. This approach is encompassed generally in the concept of "bioinspiration", which is described in this presentation using examples of biomimetic membrane systems for diagnostics and biofuel cells targeted for providing power for implantable medical devices. *Biomimetic Membrane Systems*: in this biomimetic approach to biofuel cell development, we are developing and optimising a biomimetic membrane to create a biofuel cell that utilises electrolytes for fuel. The biomimetic fuel cell generates