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Extended Abstract
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Mass Spectrometry 2017: Tandem mass spectrometry as a tool for tailoring animal disease diagnostics based on biomarker discovery: Molecular imprinting approach

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Zoonotic and transboundary animal disease control is a top priority in many health concerned organizations/institutions. The identification of the diversity of animal disease biomarkers or epitopic fractions like proteins, glycoproteins and lipopolysaccharides has a potential diagnostic/therapeutic importance. Biomarker discovery and proteomics have become synonymous with mass spectrometry in recent years. Tandem Mass Spectrometer (MS-MS) is a multistage mass analysis steps that may be either separated in space using multiple instruments or separated in time using a single mass hybrid spectrometer. MS-MS techniques starting from ion-trap (IT) to MALDI-TOF MS or their hybrid techniques are powerful platforms for proteomics analysis have been developed over the past decades. Comprehensive array of antibodies, recombinant proteins, epitopes or haptens that can be used in innovating diagnostics of animal diseases and to monitor animal health are widely being investigated. Various analytical strategies have been developed for mass spectrometry-based biomarker-discovery platforms to overcome many challenges and biological variability and anomalies. Biorecognition is central to various biological processes and finds numerous applications (sensors/affinity separation and synthetic catalysis) in virtually all areas of chemistry, biology and medicine. Scientists have been working for decades to mimic the exquisite molecular recognition ability of biological molecules such as antibodies, enzymes and receptors. Artificial antibodies, produced by imprinting synthetic polymers are designed to mimic the biological (biomimetic) recognition capability of natural antibodies, while exhibiting superior thermal, chemical and environmental stability compared to their natural counterparts. The binding affinity of artificial antibodies to their antigens characterizes the biorecognition ability of these synthetic nanoconstructs and their ability to replace natural recognition elements. However, a quantitative study of the binding affinity of an artificial antibody to an antigen, especially at the molecular level is still lacking. Several international organizations such as WHO, OIE, FAO and EPA called upon the development of rapid, sensitive, low cost and easy to use early diagnosis of pathogens rapid field test or point of care diagnostics. The detection and monitoring diseases has been a huge burden due to the high cost of reagents, laboratory sophisticated equipment and trained personnel. Most expenses spent for disease diagnoses go to analytical and diagnostic devices. Moreover, laboratories are hard to find in remote epidemic areas. There has been tremendous development and advancements in the field of molecular biology, nanotechnology and bioelectromechanical Microsystems (BioMEMS). These advanced technologies led to the development of bio-microchip devices for the detection of chemical and biological hazards. Lab-on-a-chip technique is one of the top emerging technologies. Proteins will be identified by mass spectrometry-based proteomic methods. The successful candidate will have significant product for development of clinical immunoassays and/or biomimetic sensors gained within the regulated immunodiagnostic products industry, ideally in the development of lateral flow assay (LFA) kit based products. Computational chemistry tools will aid this developmental approach upon conformational decisions of antigenic fractions that have diagnostic importance. Development and production of rapid point-of-care tests for the global veterinary diagnostics market is the golden goal to be reached.

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Tandem mass spectrometry is an instrumental analysis technique. In order to increase their capabilities for analyzing the chemical samples, two or more mass analyzers are coupled together by utilizing an additional reaction step. The analysis of biomolecules, like proteins and peptides, is a common use of tandem-MS. The molecules of a given sample are ionized and the first spectrometer (designated MS1) separates these ions by their mass / charge ratio (often given in m / z or m / Q). The ions of a particular m / z ratio from MS1 are selected and then divided into smaller fragment ions. The fragmentation step identifies and separates the ions that have very similar m / z ratios in regular mass spectrometers. For tandem mass spectrometry in space, the different elements are often noted in an abbreviated form, giving the type of mass selector used.

With surface induced dissociation (SID), fragmentation is the result of the collision of an ion with a surface in high vacuum. Years ago, it was common to use SID only on lower mass species, loaded individually, as ionization methods and mass analyzer technologies were not advanced enough to train, correctly transmit or characterize high m / z ions. Over time, self-assembled monolayer surfaces (SAM) composed of CF3 (CF2) 10CH2CH2S on gold have been the most used collision surfaces for SID in a tandem spectrometer. SAMs acted as the most desirable collision targets due to their typically large effective masses for collision of incoming ions. In addition, these surfaces are composed of rigid chains of fluorocarbon, which do not significantly dampen the energy of projectile ions. Fluorocarbon chains are also beneficial due to their ability to resist the easy transfer of electrons from the metal surface to the incoming ions.

SID's ability to produce sub-complexes which remain stable and provide valuable information on connectivity is unmatched by any other dissociation technique. Since the complexes produced from SID are stable and maintain a charge distribution on the fragment, this produces a unique spectrum, which the complex centers on a narrower m / z distribution. The SID products and the energy at which they are formed reflect the strengths and topology of the complex. The unique dissociation models allow us to discover the quaternary structure of the complex. The symmetrical charge distribution and the dependence on dissociation are unique to SID and make the product spectra distinctive from any other dissociation technique.

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