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Mass Spectrometry & Purification Techniques

Opinion Article

Applications of Mass Spectrometry

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DESCRIPTION

A useful technique for determining the chemical make-up of a sample or molecule is mass spectrometry. It has been used more recently to categorise biological products, particularly proteins and protein complexes, in a variety of species. Typically, molecular weight measurements are used to categorise unknown chemicals, measure existing compounds, and establish the structure and chemical characteristics of molecules.

Positive ion production serves as the foundation for mass spectroscopy. For its most well-known model, the electron impact ionisation with magnetic sector analyzer, the sample under study is transformed into vapour phase and bombarded with electrons having energy sufficient to knock out one electron from it (>10 eV), producing a positively charged ion known as a molecular ion or parent ion, denoted by M+. The extensive ranges of applications which can be completed by using mass spectrometry are described below.

Mass spectrometry in proteomics

The characterisation and sequencing of various proteins now need the use of mass spectrometry. Mass spectrometry has been transformed by the invention of two soft ionisation methods that can ionise proteins: matrix-assisted laser desorption/ionization and electrospray ionisation.

Clinical medicine

Significant improvements came about as a result of the application of mass spectroscopy in clinical laboratories. Because of its increased sensitivity, mass spectroscopy holds a useful place in clinical analysis when a higher degree of sensitivity is necessary because the analyte quantity is too low. Any medical condition causes changes in the body's chemistry that can be identified for diagnostic purposes using chromatographic equipment like gas chromatography equipped with mass spectroscopy. These changes in body chemistry result in changes in body fluids and excretion products. It is currently popular to directly analyse and visualise pharmaceutical chemicals in intact tissue using Matrix-assisted Laser Desorption/Ionization Mass Spectrometry (MALDI-MS).

Mass spectrometry imaging

The technology known as Mass Spectrometry Imaging (MSI) allows users to see how molecules are distributed in space. Micrometer-sized portions on surfaces can be used to generate mass spectra, which can be used to connect optical pictures with the lateral distribution of chemicals on surfaces (microelectronics, tissue slices). Common ionisation technologies include secondary ion mass spectrometry imaging, DESI imaging, and MALDI imaging (SIMS imaging).

Geology and space science

Astronomy and environmental sciences are two fascinating fields where mass spectrometry is being used. By examining the petroleum precursors in rock, MS may map out the elements and isotopes in solar wind, keep track of climatic changes, and find oil resources globally. NASA therefore makes extensive use of MS equipment to study the cosmos. To calculate the amount of chemicals and toxins present on the planet Saturn, for instance, the atmosphere's composition and quality are examined.

Forensic applications

Because the sample size is so small in forensic research, high sensitivity is needed for the analysis. In the forensic sector, gas chromatography and mass spectroscopy have become vital tools, and LC-MS has also found extensive use in forensic research. Because there is more desire to analyse drug usage by examining body fluids and tissues, mass spectroscopy is becoming more important in forensic studies. Urine, hair, and blood are the main samples used in drug abuse forensics. Opiates, cocaine, marijuana, Lysergic Acid Diethylamide (LAD), amphetamines, and marijuana are a few of the drugs that are regularly analysed. The analysis of these drug candidates will also focus heavily on incidents of homicides or deaths from poisoning and drug overdose.

Mass spectrometry in glycomics

More than half of all mammalian proteins can be glycosylated, making it one of the most significant PTMs. The goal of

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Received: 24-Jun-2022, Manuscript No. MSO-22-18674; **Editor assigned:** 28-Jun-2022, PreQC No. MSO-22-18674 (PQ); **Reviewed:** 14-Jul-2022, QC No. MSO-22-18674; **Revised:** 21-Jul-2022, Manuscript No. MSO-22-18674 (R); **Published:** 28-Jul-2022, DOI:10.35248/2469-9861.22.8.158.

Citation: Billakurthi BS (2022) Applications of Mass Spectrometry. J Mass Spectrom Purif Tech. 8:158.

glycocomics, a branch of glycobiology, is to characterise the composition and purpose of the glycome. The analysis of free oligosaccharides, glycosaminoglycans, glycoproteins, proteoglycans, and glycolipids using MS-base glycomics is common. For glycoconjugate analysis, two popular techniques are Matrix-Assisted Laser Desorption-Ionization (MALDI) and Electrospray Ionisation (ESI). MS can be used independently or in conjunction with other separation techniques including Capillary Electrophoresis (CE) and High Performance Liquid Chromatography (HPLC).