High-performance liquid chromatography (HPLC) in drug discovery: Current practices and future directions.

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High-performance liquid chromatography (HPLC) is a cornerstone technique in the pharmaceutical industry, playing a pivotal role in drug discovery and development. It's robust, versatile, and reliable nature enables the analysis of a variety of samples, providing valuable data about the purity, chemical properties, and concentration of potential therapeutic compounds. HPLC is an advanced form of column chromatography, a technique that separates compounds within a mixture. By forcing a solvent containing the mixture through a column packed with small particles under high pressure, HPLC can differentiate compounds based on their interaction with the stationary phase (column material) and the mobile phase (solvent). Compounds that interact more with the stationary phase take longer to traverse the column and are separated from those that interact more with the mobile phase [1].

Compound isolation and identification HPLC helps isolate and identify active compounds from natural products or synthetic mixtures. It allows the separation of a complex mixture into individual components, which can then be further investigated for potential therapeutic activity. Analysis of metabolites metabolism studies are critical in drug discovery to understand how a potential drug is processed in the body. Hplc can identify and quantify metabolites, contributing to a comprehensive understanding of a drug's pharmacokinetic profile. Determination of purity it is essential to ensure the purity of a drug candidate for accurate activity and safety testing. Hplc is often used to determine the purity of samples by separating and quantifying impurities. Quantitative analysis HPLC is widely used in bio analytical studies to measure the concentration of drugs and their metabolites in biological samples. It provides essential data for dose-response studies, helping to establish optimal dosage levels [2].

HPLC technology has advanced significantly over the years, with improvements in both hardware and software. Ultra-High Performance Liquid Chromatography (UHPLC) represents one such advancement, offering even higher pressure operation and smaller particle sizes for increased resolution and speed [3].

The development of novel stationary phase materials also allows more effective separations. For example, the introduction of core-shell particles and monolithic columns has led to significant improvements in chromatographic efficiency. Another notable advancement is the integration of mass spectrometry with HPLC (LC-MS). This powerful combination provides both qualitative and quantitative information, enhancing the accuracy and reliability of drug analysis [4].

The future of HPLC in drug discovery looks promising, with ongoing advancements expected to further improve efficiency and versatility. Micro and Nano LC: Miniaturization into micro or nano LC can potentially offer increased sensitivity and lower sample requirements, which is particularly useful in proteomics and metabolomics studies. Two-Dimensional LC (2D-LC): This technique combines two different types of liquid chromatography in sequence, providing superior separation power. It is especially beneficial in the analysis of complex biological samples. HPLC is undeniably a critical tool in drug discovery, contributing to the development of numerous therapeutics over the years. As technological innovations continue to evolve, so too will the capabilities of HPLC. From increased speed and resolution to the integration of AI, the future of HPLC holds exciting potential to further accelerate and refine the drug discovery process [5].

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