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Ionic Liquids' Role in Drug Delivery Systems and Recent Advances

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Introduction

Ionic liquid advancements broaden their applications not only in traditional applications but also in various pharmaceutical and biomedical fields. Ionic liquids "Solutions for Your Success" have piqued the interest of scientists due to a plethora of applications in the pharmaceutical industry for drug delivery systems as well as disease targeting. Solubility is an important physicochemical property that determines the fate of the drug at the target site. Because of poor solubility, many promising drug candidates fail at various stages of drug development. Ionic liquids are regarded as effective drug delivery systems for poorly soluble medicines in this context. ILs can also combine different anions/cations with other cations/anions to produce salts that satisfy the ILs concept [1].

Description

At room temperature or below 100 °C, ionic liquids are salts that contain poorly coordinated anions and cations. Ionic fluids, ionic melts, liquid electrolytes, fused salts, liquid salts, ionic glasses, designer solvents, green solvents, and solvents of the future are all names for ILs. ILs have gained prominence due to their unique physiochemical properties since 1914, when Paul Walden published the first article on ionic liquids concerning ethylammonium nitrate. Wilkes and Zaworotko discovered in 1992 an imidazolium-based IL that is both air- and water-stable at room temperature, broadening the field's applicability beyond synthetic chemistry and into biomedical fields. ILs are green solvents used in green technology, but other methods of green synthesis can also be used.

Ionic liquids are a type of material made up of ions that have unique properties such as high thermal stability, high solvating power, and low vapour pressure. These characteristics of ILs are extremely useful in a wide range of applications, including pharmaceutical drug discovery. The development of new solvents for chemical synthesis is one of the most important applications of ionic liquids in drug discovery. ILs can be used as solvents in a variety of reactions, including organic synthesis, and can also be used to increase compound solubility in aqueous media, making it easier to purify and isolate compounds. This is also critical in the early stages of drug development. Another use of ILs in drug discovery is the development of new drug delivery systems [2,3].

Another use of ILs in drug discovery is the development of new drug delivery systems. To deliver drugs to specific target sites, ILs can be used to create nanoparticles and micelle structures. It can also be used to make solid dispersions, which can improve drug bioavailability and solubility. Recent research has broadened the field and defined ILs as salts with lower melting points around 100 °C and an infinite range of optimizable properties like volatility, toxicity, instability, and flammability. ILs, which were previously thought to be salts of imidazolium, pyrrolidinium, quaternary ammonium, phosphonium cations, or pyridinium, have expanded to include bioinspired cations of guanidinium, cholinium, and metal-based cations.

They react with various anions to form salts that satisfy the concept of ILs. The emergence of more complex compounds supports the theory that the heterogeneity of an asymmetric sterical cation's structure strongly interferes with both arranged packing inside a crystal lattice and interaction with anions, accounting for the compounds' characteristically low melting point. Furthermore, because of the recent chemical space expansion, it is now possible to construct ILs with customised properties for both theoretical research and real-world applications. Application-driven IL research is a thriving and expanding field with new therapeutic horizons, particularly in drug delivery.

ILs have been investigated as a sustainable and alternative reaction medium for many organic modifications, including the production of therapeutic compounds. When compared to traditional organic solvent reactions, those in ILs are often faster and simpler to carry out, and they typically do not require any sophisticated equipment or methods. Regardless of the wide range of alternative cations and anions now available in the IL toolbox, cations such as paired with the (NTf2), (BF4), or (PF6) anions have been used as media in the synthesis of APIs. The use of ILs as reaction media in the synthesis of nucleoside-containing antiviral drugs such as stavudine, trifluridine, and brivudine is well documented in the literature.

Drug delivery systems are important factors in determining a drug's effectiveness and must be designed in such a way that the drug is not subjected to unfavourable metabolism and is transported to the target at an acceptable rate. However, there are several physiological barriers that prevent the drugs from being transported effectively. For example, the stratum corneum impermeability, which presents a barrier to chemical absorption, continues to pose a challenge to topical and transdermal drug delivery, providing alternatives to injectable and oral methods. As a result, a variety of methods, such as chemical enhancers, are used to overcome the obstacles and ensure effective drug delivery [4,5].

Conclusion

The purpose of this study is to summarise and inspire ongoing ionic liquid research motivated by biological applications. The characteristics of ILs can be modified for a variety of biological purposes thanks to the ions' high structural diversity and easy coupling properties. Advances in this field have demonstrated how ILs can improve drug permeability across physiological barriers, promote the dissolution of pharmaceuticals with low solubility, and provide a method for designing API-ILs. The results have been quite positive, with this IL-hallmarks strategy of improved bioavailability and effectiveness. Metal-containing ILs performed better in biosensing and glucose detection. In the biomedical industry, ILs can be viewed as a viable strategy for addressing a variety of issues, including the bioavailability of pharmaceuticals, anti-infectives, and biosensors. Given metals' magnetic, optical, and radioactive properties, we believe the emerging field of ILs incorporating metals may offer new opportunities, such as in bioimaging. Toxicity is a significant risk when

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using ionic liquid. Toxicity, on the other hand, can be reduced through rational formulation design. Finally, ILs represent an unexplored field with enormous therapeutic potential.

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