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Opinion Article

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Exploring Green Chemistry Approaches to Synthesize Antiviral Compounds

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DESCRIPTION

Green chemistry, a modern method of chemical synthesis, seeks to reduce or eliminate harmful compounds while increasing sustainability and efficiency in order to have as little of an impact as possible on the environment. Its potential uses in pharmaceutical research, namely in the synthesis of antiviral drugs, provide avenues for developing potent therapies while tackling environmental issues. Given the importance of antiviral drugs in the fight against viral infections including influenza, HIV, hepatitis and, more recently, COVID-19, which poses a danger to world health, this strategy is particularly pertinent. This essay examines the several advantages and difficulties of using green chemistry concepts in the manufacture of antiviral drugs. The twelve principles of green chemistry, which include waste prevention and the use of renewable feedstocks, serve as a guide for scientists in creating more sustainable synthesis processes. In the context of antiviral synthesis, several principles are particularly significant: Atom Economy focuses on maximizing the use of all reactant atoms to minimize waste and enhance efficiency. The use of bio-based resources, such as chemicals originating from plants, as starting points for synthesis is encouraged by the use of renewable feed stocks. A key component of large-scale pharmaceutical manufacture is energy consumption, which may be decreased by promoting the use of ambient temperatures and pressures for chemical reactions. The Reducing Derivatives approach, which streamlines the medicine production process while minimizing its environmental effect, highlights that fewer reaction stages result in less waste and dangerous chemicals. The pharmaceutical sector is rapidly embracing the objective of creating antiviral medicines with a small ecological imprint, which may be achieved *via* the use of green chemistry concepts.

Natural products and green solvents in antiviral synthesis

Antiviral medications have long been developed using natural components as their foundation. Several bioactive chemicals found in plant-derived substances, for example, can be used to enhance their antiviral effects. Green chemistry techniques for natural product extraction use eco-friendly solvents such supercritical CO_2, ethanol and water. Reducing waste and enhancing sustainability, these solvents take the role of conventional organic solvents, which are frequently hazardous to the environment. Green solvents help in the synthesis of antiviral drugs by enabling techniques like supercritical fluid extraction and microwave-assisted extraction, which enable the more effective and selective extraction of bioactive chemicals. For instance, because supercritical CO_2 is recyclable, non-flammable and non-toxic, it is a great option. The integrity of delicate antiviral substances is also maintained by its operation at modest pressures and temperatures. Because they support the objectives of green chemistry, which include lowering hazardous waste and enhancing process efficiency, these approaches are becoming more and more popular than conventional ones.

Catalysts and enzymes in antiviral synthesis

Catalysts play a essential role in reducing the environmental impact of chemical reactions by minimizing the amount of energy required and increasing reaction efficiency. In the context of green chemistry for antiviral synthesis, catalysts are essential, particularly biocatalysts such as enzymes, which offer specific and efficient reaction pathways. Enzymes derived from plants, bacteria and fungi are biodegradable and operate under mild conditions, making them suitable for green synthesis. For instance, lipases and oxidoreductases are commonly used in pharmaceutical synthesis due to their ability to facilitate reactions with high specificity and minimal byproduct formation. Enzymes are particularly effective in synthesizing nucleoside analogs, which form the basis of many antiviral drugs, including those used for HIV and hepatitis B. By using enzymes as catalysts, the pharmaceutical industry can reduce its reliance on hazardous chemicals while enhancing the selectivity of antiviral synthesis, which often results in fewer purification steps and lower costs. Another effective green chemistry catalyst is the use of Metal-Organic Frameworks (MOFs), which are highly porous materials that can be tailored to various reactions. MOFs have shown promise in antiviral drug synthesis, particularly for their efficiency in catalyzing complex reactions and their ability to be recycled, which aligns well with sustainable practices.

In conclusion, green chemistry methods for creating antiviral drugs present a viable way to solve issues with the environment and world health. Scientists are creating antiviral medications with smaller environmental impacts by applying concepts like atom economy, renewable feedstocks and safer synthesis techniques. Even if there are still obstacles to overcome, developments in waste reduction strategies, enzymatic processes and green catalysts are opening the door to more environmentally friendly antiviral manufacturing. Green chemistry is positioned to play a significant role in the development of antiviral drugs in the future, supporting environmental sustainability and human health *via* further research and innovation.