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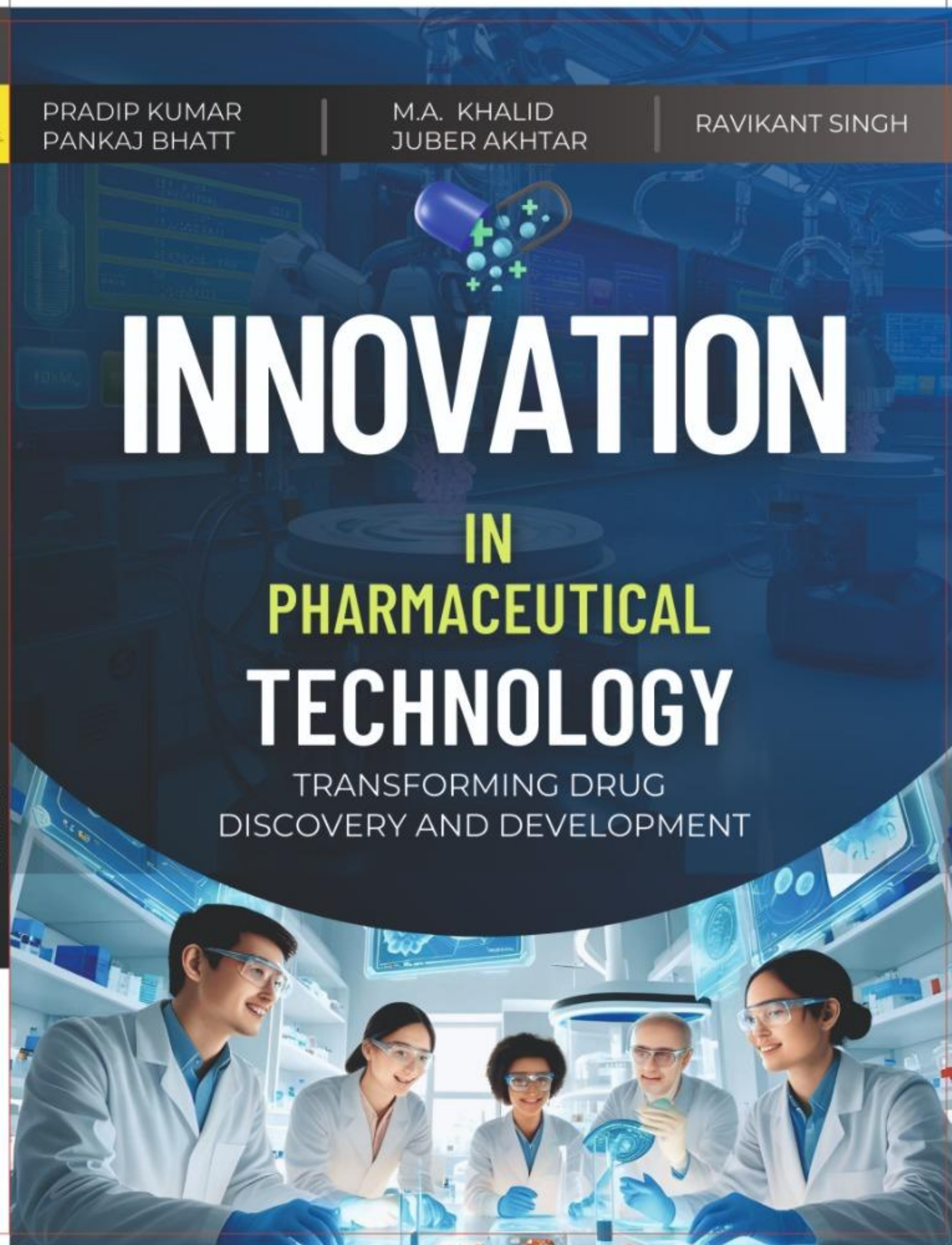
INNOVATION IN PHARMACEUTICAL TECHNOLOGY
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PHARMACEUTICAL SUSTAINABILITY AND GREEN CHEMISTRY

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ABSTRACT : One crucial instrument for attaining sustainability is green chemistry. If the growing world population is to enjoy a higher standard of living without negatively affecting the health of the planet, green chemistry—the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances—must be put into practice. The chemical industry will be able to responsibly supply society with the commodities and services it depends on, thanks to cleaner technology. Green chemistry offers answers to global issues like energy, climate change, sustainable agriculture, environmental pollutants, and resource depletion. About 80% of the total volume of chemicals utilized in many significant chemical processes, particularly the production of fine compounds, are chemical solvents. Regretfully, these solvents are frequently volatile organic chemicals derived from petroleum-bearing numerous hazards to the environment and human health. These two factors are used by many researchers as justifications for looking for new environmentally friendly solvents to replace the traditional ones. Pharmaceutical companies rely heavily on green chemistry to create new medications that are less harmful, more efficient, and have fewer adverse effects. The most recent viewpoints on GC and SC education and capacity building will be discussed. Proving their vital role in transforming institutional, infrastructure, and human resources settings across all industries on a wide scale in order to produce useful, cutting-edge information that can be implemented in more sustainable and eco-friendly goods and procedures in a demanding society.

Key words : Green chemistry, eco-friendly goods, human health, hazardous substances.

Introduction

“Development that fulfills the demands of the present without compromising the potential of future generations to meet their own needs” is how the Brundtland Commission (1987) defined sustainable development. However, society’s current behaviors are unsustainable. The world’s population is still growing, natural resources are being depleted more quickly than they are being restored, and significant amounts of dangerous compounds are being discharged into the environment. For instance, in 2001, about six billion pounds of the 522 chemicals on the Toxics Release Inventory (2001) were released in the United States, both on and off-site (Martín-Matute *et al*, 2021)

How can science tackle the sustainability problem, particularly while the world’s resources are being strained by a growing population and rising living standards?

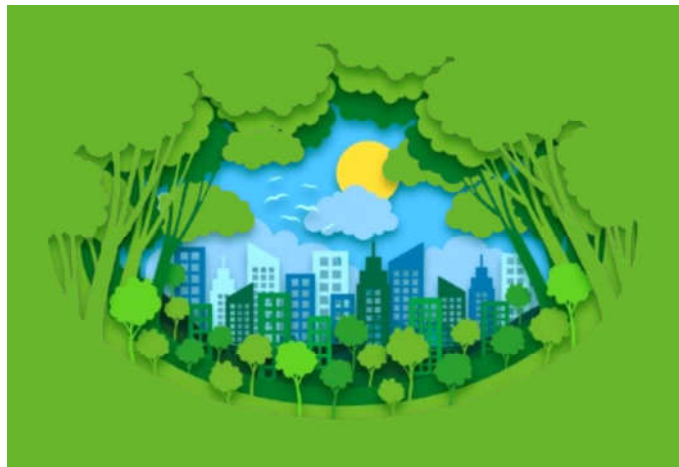


Fig. 1 : Green chemistry: A Boon to our society.

Innovations in science must be crucial to overcoming this obstacle. While many unexpected environmental issues have been brought about by technological advancements, many of these issues can be resolved thanks to scientific discoveries. One such opportunity is offered by “green chemistry” (Kirchhoff, 2005).

An inventive scientific field called “green chemistry” signifies a paradigm shift in the understanding of chemical processes created and put into action. It

represents a comprehensive rethinking of conventional chemical processes with an emphasis on efficiency, sustainability, and environmental effects. Green chemistry has become a ray of hope as worries about resource depletion, environmental degradation and the harmful effects of chemical products and processes on human health have grown. This is especially true for sectors like pharmaceuticals where chemical processes play a crucial role. Designing chemical products and processes to reduce the use and production of hazardous compounds is the fundamental idea behind green chemistry.

This strategy seeks to minimize waste, stop pollution, and produce safe chemical products for the environment and human health. Green chemistry is founded on twelve guiding principles that support methods, including atom economy, waste reduction and the utilization of renewable feedstocks. The implementation of green chemistry principles is crucial in the pharmaceutical industry since drug development is a complex process that has historically been linked to major environmental impacts. Traditional pharmaceutical procedures frequently use a lot of energy, produce a lot of trash, and use a lot of dangerous solvents.

Green chemistry, however, provides workable substitutes and remedies to lessen these problems. Innovative synthetic techniques, biocatalysis and renewable feedstocks can all help the pharmaceutical business drastically lessen its environmental impact. Employing these techniques leads to safer formulations, more effective medication production, and more sustainable manufacturing procedures. For instance, using renewable starting materials results in a more sustainable supply chain for pharmaceutical products by lowering waste production and dependency on petrochemical sources. Green chemistry’s incorporation into pharmaceutical procedures is further demonstrated by the use of safe solvents and the creation of catalytic processes. Through the elimination or drastically reduced usage of hazardous compounds, these techniques not only improve worker and customer safety but also lessen their influence on the environment (Kumar and Pandey, 2023).

Over almost 20 years, the ideas and methods of Green Chemistry have grown into an international initiative to achieve the “triple bottom line”—sustainability in terms of economic, social, and environmental performance. There are still many problems to be solved, and