Microbial Bioprocesses

Applications and Perspectives

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Chapter 12 - Microalgal-based bioremediation of emerging contaminants in wastewater: a sustainable approach

Abhijeet W. Singh [1 a], Ramendra Soni [1 a], Arun Kumar Pal [1 a], Pooja Tripathi [2], Jonathan A. Lal [1], Vijay Tripathi [1]

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CHAPTER 12

Microalgal-based bioremediation of emerging contaminants in wastewater: a sustainable approach

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1. Introduction

Emerging contaminants (ECs) are a new class of natural or synthetic substances that causes adverse or negative side effects on ecological and individual health (Bilal et al., 2019). Recently, ECs have occurred in various water resources such as groundwater, untreated/treated wastewater (WW), and river water and food sources and aroused as a major challenge for the global population (Williams et al., 2019). Chemical pollutants are not well studied so far and still unregulated (Brusseau & Artiola, 2019). The most widespread ECs contain antibiotics, heavy metals (HMs), pesticides, pharmaceutical personal care products (PPCPs), endocrine disruptors, organic dyes, and organic hydrocarbons (Khan, Naushad, et al., 2022; Shanle & Xu, 2011). Such pollutants are commonly found in the aquatic environment and have recently been identified as important water contaminants. According to many studies these ECs are potentially life-threatening mainly causing infertility, neuro diseases, abnormal growth, degrading aquatic life, and harming the human immune system (Gomes et al., 2018; Khan, Naushad, et al., 2022). It is important to note that the majority of ECs are not recently documented but are already well-known pollutants with newly reported harmful effects (Ahmed et al., 2021; Rasheed et al., 2018). The existence of many ECs in the aquatic environment is generally through WW outflow from wastewater treatment plants (WWTPs) and lack of treatment technologies with insufficient removal efficiencies can increase these contaminants in downstream environments (Agüera et al., 2013). It has been found that WWTPs are not exactly designed to remove them but only partial removal of various ECs has been reported (Al-Maqdi et al., 2021; Petrovic, 2003). Therefore, recently several researchers are focusing on the removal of ECs from natural water resources (Kárászová et al., 2020; Vasilachi et al., 2021; Yang et al., 2017).

[a] Authors have equally contributed.

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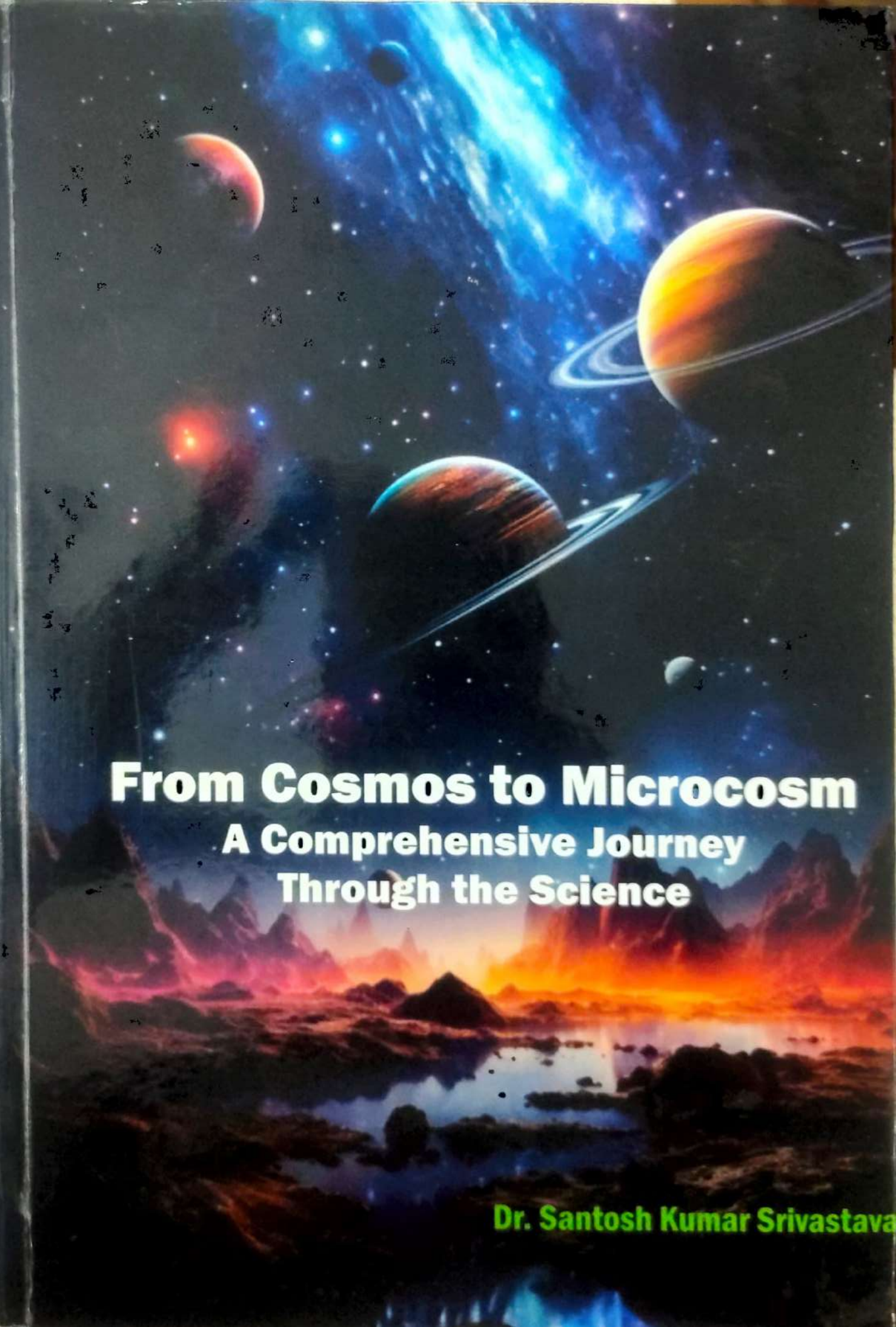

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Biological and Medical Applications of Heterocyclic Compounds

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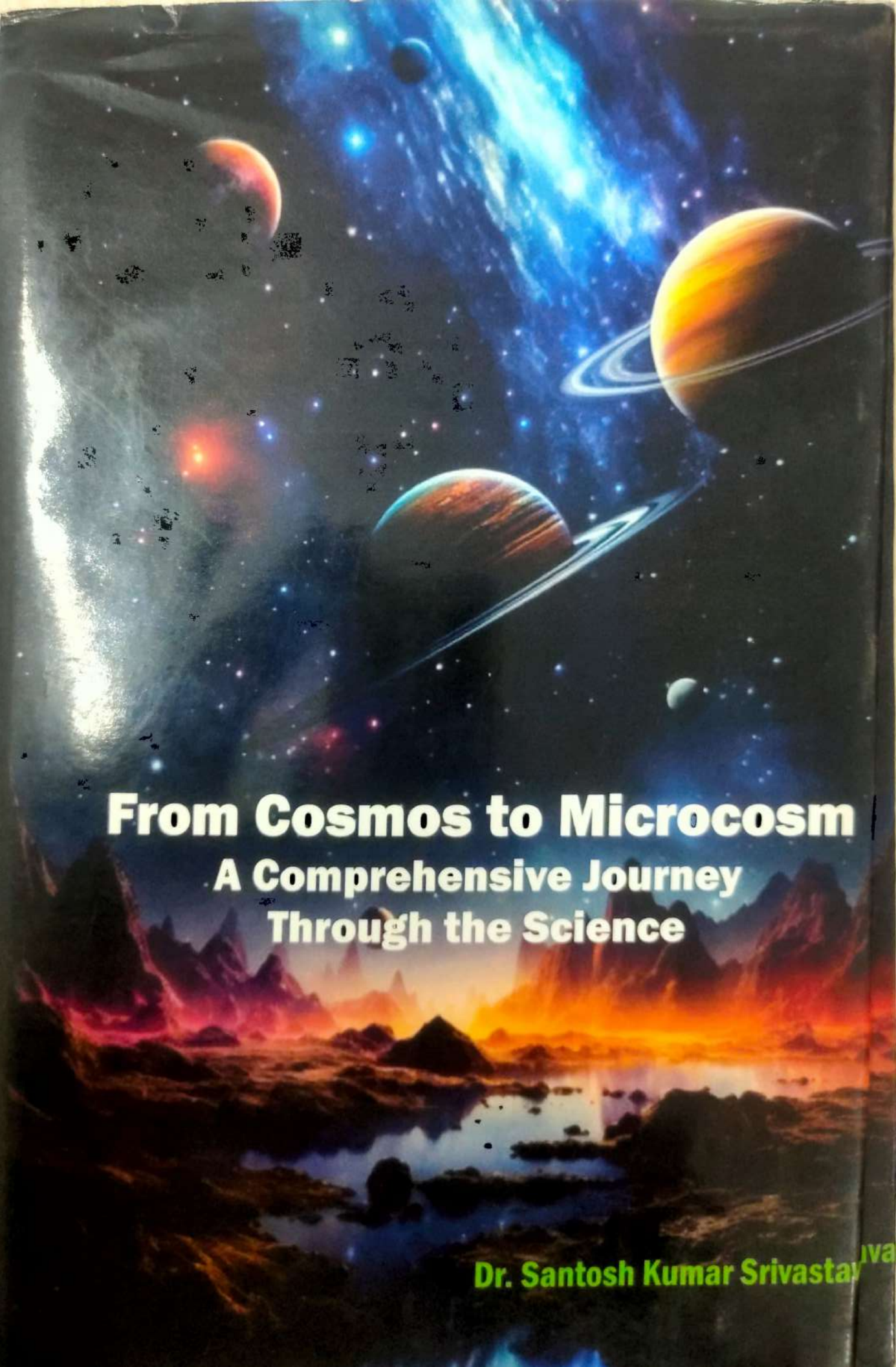
Abstract

Heterocyclic compounds have attracted chemist owing to their multiple important medical and biological uses. Researchers are keen to work on heterocyclic compounds because of the comprehensive synthetic analysis and functional requirements. They are present in majority of new drugs, and bridge the gap between biology and chemistry, where most of scientific discovery and application takes place. Heterocycles play a beneficial role in various branches, incorporating medicinal chemistry, biochemistry, etc. Pharmaceuticals, agrochemicals, and veterinary entities are the major applications of heterocyclic compounds. In this chapter, the maximum number of bio-active heterocycles that have currently been prepared and introduced a novel phase of feasible antifungal, anti-inflammatory, anti-bacterial, antiviral, antioxidant, anticonvulsant, anthelmintics, anthelmintic antipyretics, anti-allergic, anti-histamine, herbicidal, anticancer, antihypertensive as well as anti-leprosy therapeutics.

According to earlier reported research work, most of medicines constituting heterocyclic compounds have been synthesized after the procurement of a well-defined scientific knowledge of the biological system. It was discovered in synthesis of heterocyclic compounds that these play a key role in curative chemistry.

Keywords: *Heterocyclic compounds, Biological activity, Medicinal chemistry, Anticancer, Antiviral, Anti-inflammatory.*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Significance of Biosensors in Modern Science

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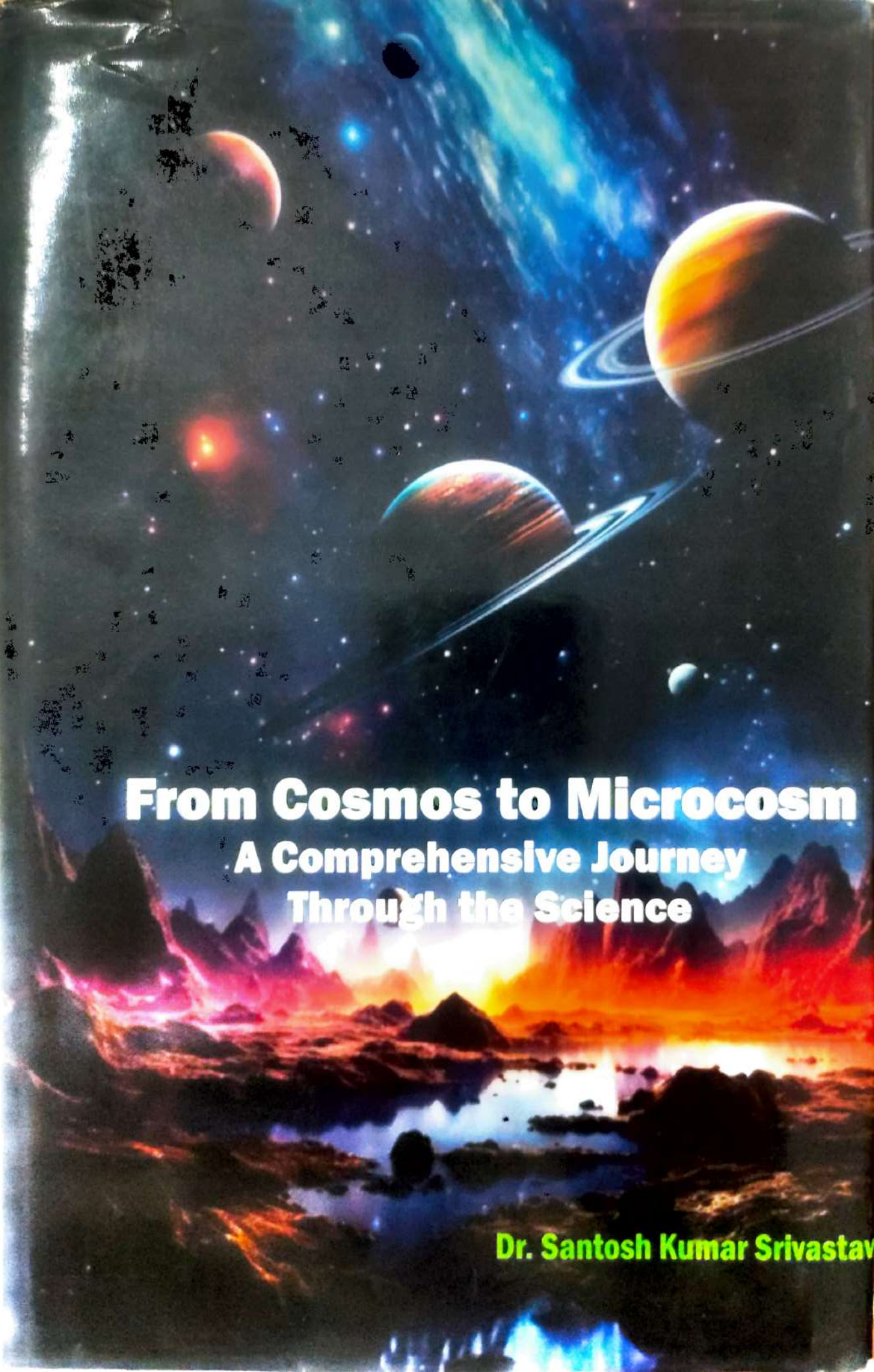
Abstract :

Rapid progress in biosensors have currently been reported. This has been feasible owing to rapid growth in the development of novel biosubstances like conducting polymers, copolymers and sol gels and the reported enhancements in sensing technical procedures. The response created as a consequence of biochemical reaction is identified by a transducer to supply a signal (optical/electrical/thermal) that can be utilised with or without magnification for the assessment of the concentration of an analyte in a known test sample. Among the several biosensors, electrochemical sensors, specifically amperometric biosensors currently secure a top position.

Owing to specificity, portability, simplicity, great sensitivity, potential calliber for pragmatic time and on-site analysis combined with the speed and minimal cost, biosensors have been exhibited to possess applications in food evaluation, environment protection, clinical detection, drug and agriculture industries and so on. Apart from this, biosensors provide interesting opportunities for number of decentralized clinical applications, varying from urgent room screening, home individual examination and substitutent site evaluation, persistent and real-time in vivo monitoring. New era of biosensors merging novel bioreceptors with the increasing number of transducers is evolving.

Keywords : *biosensor, conducting polymer, sol gels, molecular recognition, amperometric biosensors, clinical detection, transducer.*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Green Synthesis: Synthesis of Nanoparticles by Various Plant Parts

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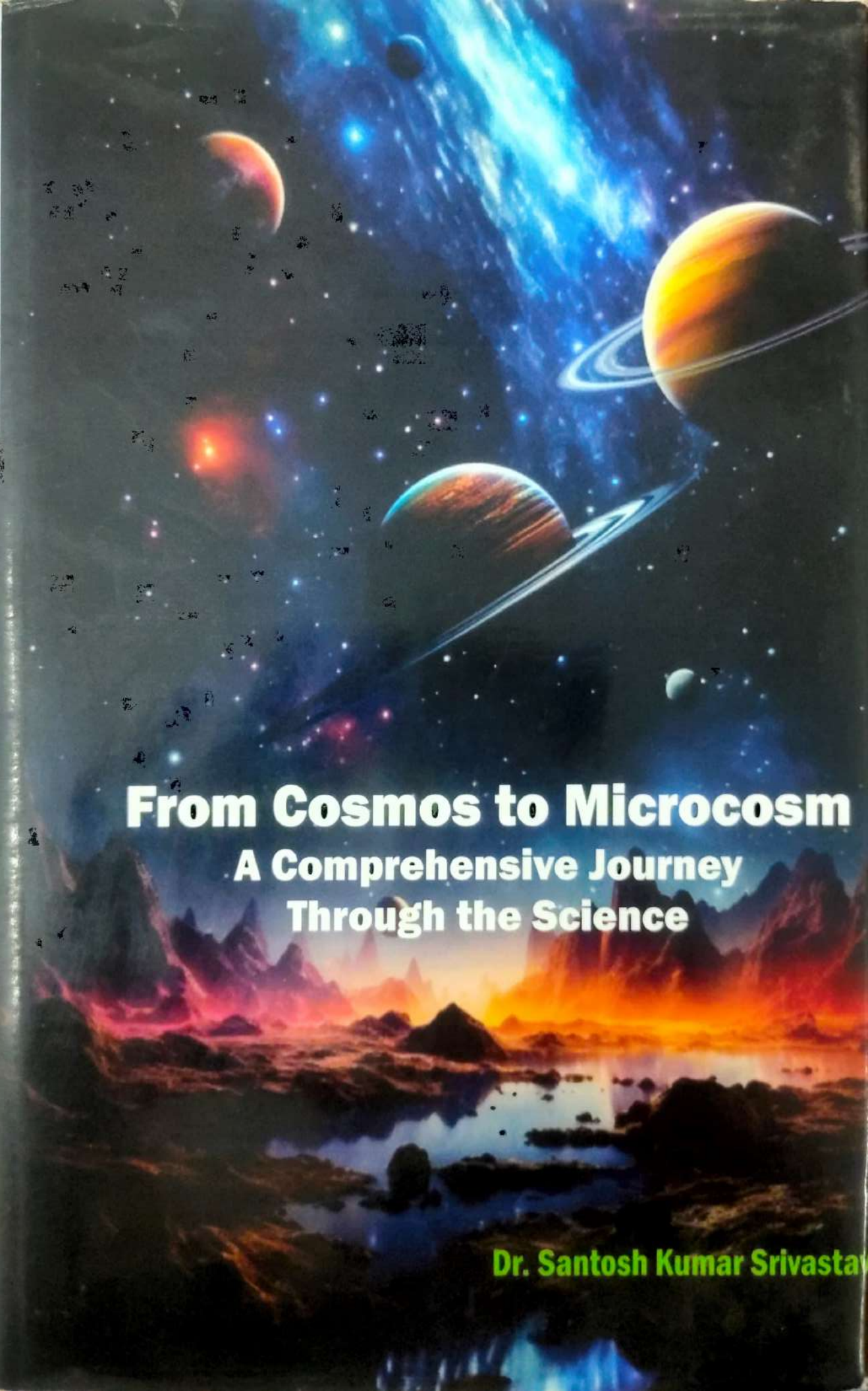
Abstract

Nanotechnology deals with the production and use of materials on a nanoscale. The nanometric size gives nanoparticles a high surface area to volume ratio and thus very specific properties. Nowadays, nanotechnology has become an important research area in all branches of science. Apparently, the size, orientation, and physical properties of nanoparticles change the properties of any material. For several years, scientists have been constantly researching various synthesis methods of to synthesize nanoparticles. In contrast, the green method of nanoparticle synthesis is simple, efficient, and environmentally friendly compared to chemical or microbiological synthesis. The synthesis of green nanoparticles has also recently attracted a lot of interest due to its advantages such as cost efficiency, simplicity, environmental friendliness, biocompatibility, ecological alternative, and wide application compared to traditional chemical and physical methods. Various types of biomolecules from microorganisms and plants are successfully used for the synthesis of metallic and nonmetallic nanoparticles. Biogenic pathways could be described as environmentally friendly since they do not require the use of highly toxic chemicals or increased energy input during synthesis. The uniqueness of green nanoparticles has enabled their potential applications in various fields such as biomedicine, pharmacology, food science, agriculture, and environmental engineering. This article summarizes the current knowledge on the different biogenic synthesis



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Future Trends and Applications of Liquid Crystals

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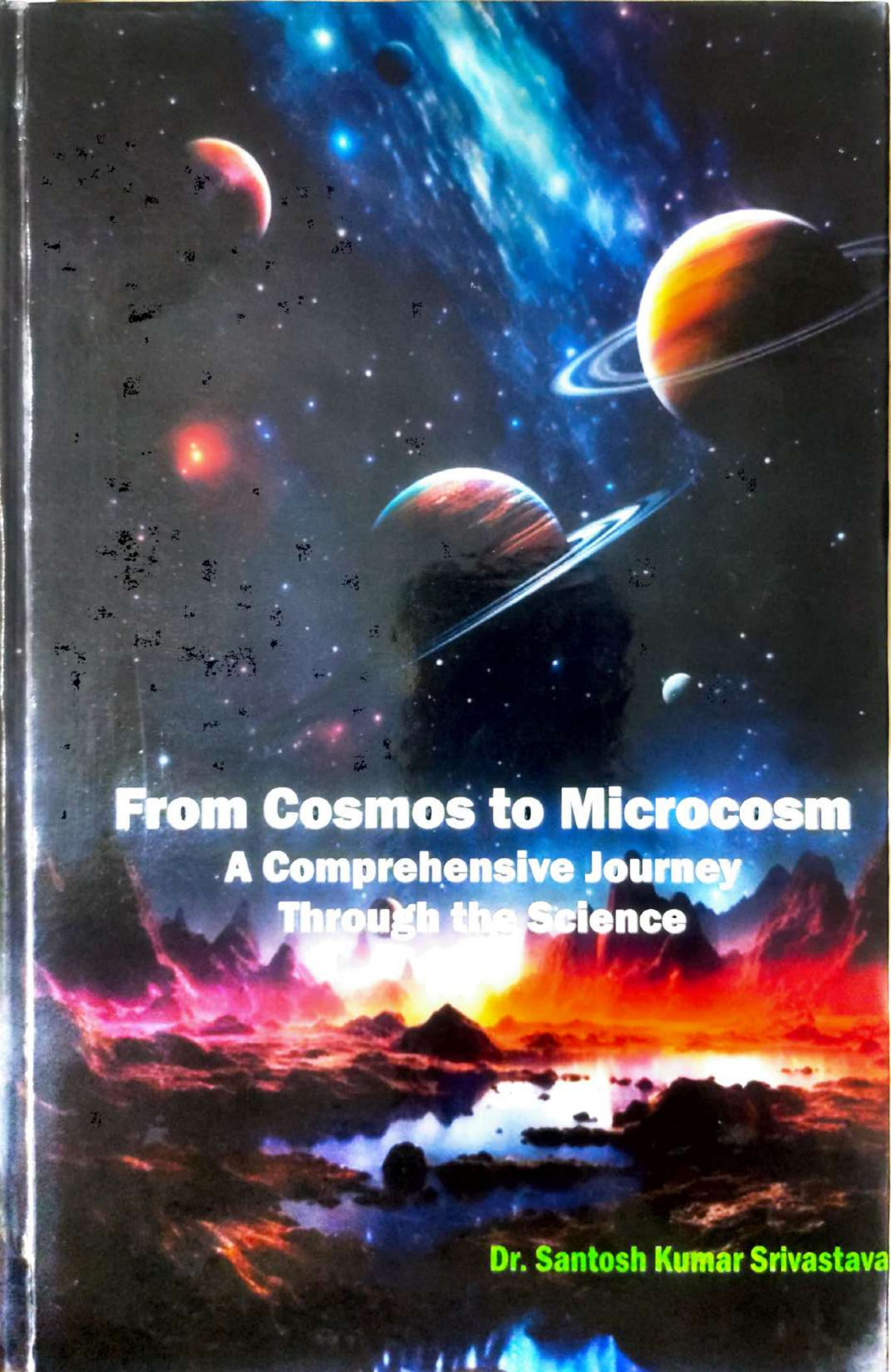
Abstract:

Liquid crystals are described as the fourth state of matter developing between solid and liquid phases. The applications of liquid crystals were limited to electronic devices in the past, but latest research discoveriesintroduce various applications of liquid crystals in biology as well as medicine. The aim is to explain and describe the potential biological effects of liquid crystals in the diagnosis and prognosis of cancer including risk evaluation.The latest developmentsof liquid crystals in cancer biomarker identification and treatment in several cell line scaffolds.The cancer diagnostics on the basis of multidisciplinary technology and employment of liquid crystals may become a substitute to routine cancer identification techniques. In addition to this, the challenges and difficulties in employing liquid crystal processes is explained. Resolving these difficult situations will need good endeavours and the step ahead is via the multidisciplinary combination of physicists, biologists, chemists, material-scientists, clinicians, as well as engineers. The significant output of these liquid crystals and their applications in cancer research would be feasible examination for the diagnosis of cancer and may consequently result in curing the malignancy patients non-invasively. The history of LC and their outcome as a precious substance for portrayinginstruments and the more latest discovery of their utilisation as sensing feature in biosensors. This novel application of LC as device in the



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Micellization of pH and Thermo-Responsive Polymers

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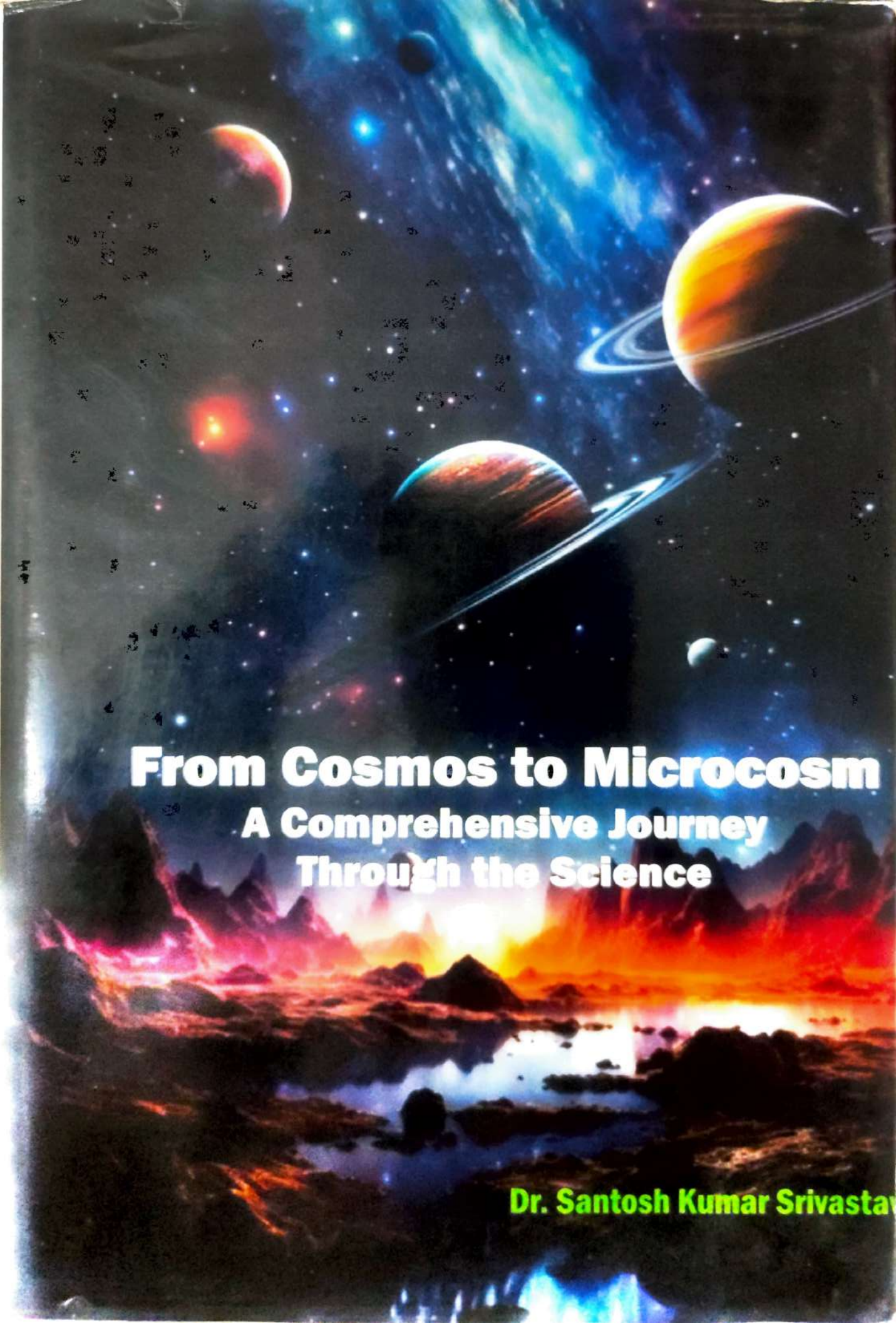
Abstract

Polymericmicelles made of stimuli-responsive polymers have a single hydrophilic shell surrounding a hydrophobic core with many compartments in a suitable environment. In response to a change in pH or/and temperature, the dual nature of stimuli-responsive polymers reveals a sharp shift in structures and properties like as conformation, hydrophilicity/hydrophobicity, solubility, size, and more. Due to developments in the synthesis of non-toxic dual pH and thermo-responsive monomer-based polymers, it is now possible to fabricate dual-responsive polymeric micelles for drug administration and imaging applications. The controlled release of materials with medicinal properties, made possible by stimuli responsive polymers, has aided in the development of drug carriers and delivery technologies. Comparing these drug release systems to traditional dosage forms, there are many benefits, including increased efficacy, decreased toxicity, and increased patient compliance and convenience. This chapter focuses on micellization of pH and thermo-responsive polymers, and their most recent and important applications as drug delivery systems in pharmaceutical industry.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Heavy Metal Ions Removal from Wastewater by Water Soluble Graft Copolymers

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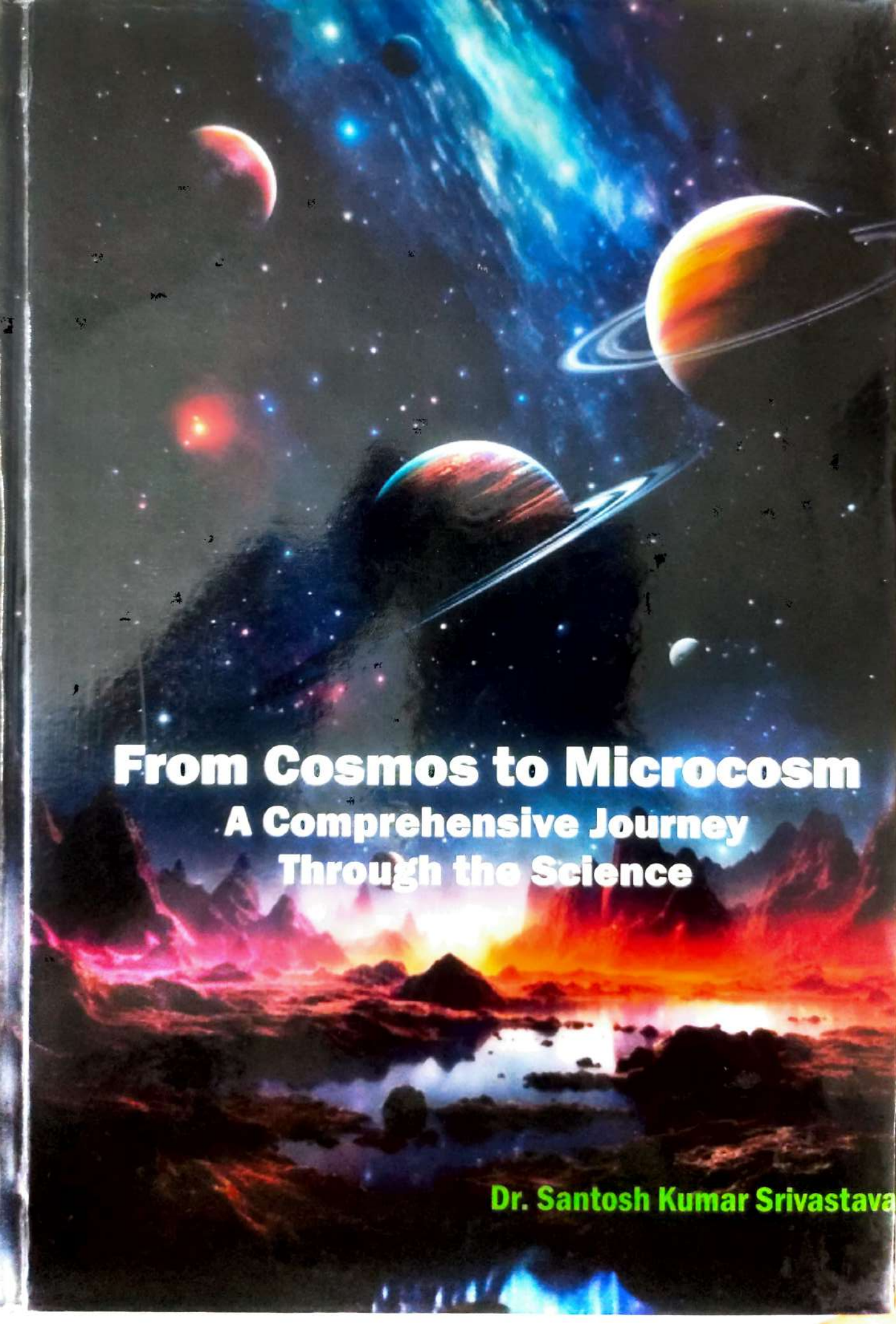
Abstract

Industrial advancements are more needed these days for global development. But this development is leading to a hazardous waste discharge in water bodies which includes heavy metal ions such as chromium, copper, cadmium, lead, mercury, nickel, zinc, etc. These metals do not get degraded and by either with the intake of water or by the intake of any aquatic food get deposited into every organisms' body, and can affect health. Therefore it is very mandatory for us to remove these heavy metals from water bodies to have safe water. For the removal of the metal ions, polymers in different forms like polymer blends, polymer composites, and graft copolymers are in concern. In this chapter we have discussed the heavy metal ions removal from wastewater by using water soluble graft copolymers, via adsorption and metal chelation methods. Further we have discussed the characterization of the adsorbed and chelated heavy metals through UV-visible spectroscopic and cyclic voltammetric methods.

Keywords:*Wastewater treatment, metal ions removal, graft copolymer, cyclic voltammetry, UV-Visible spectroscopy.*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Natural Products in Pharmacognosy - Past, Present and Future Prospects

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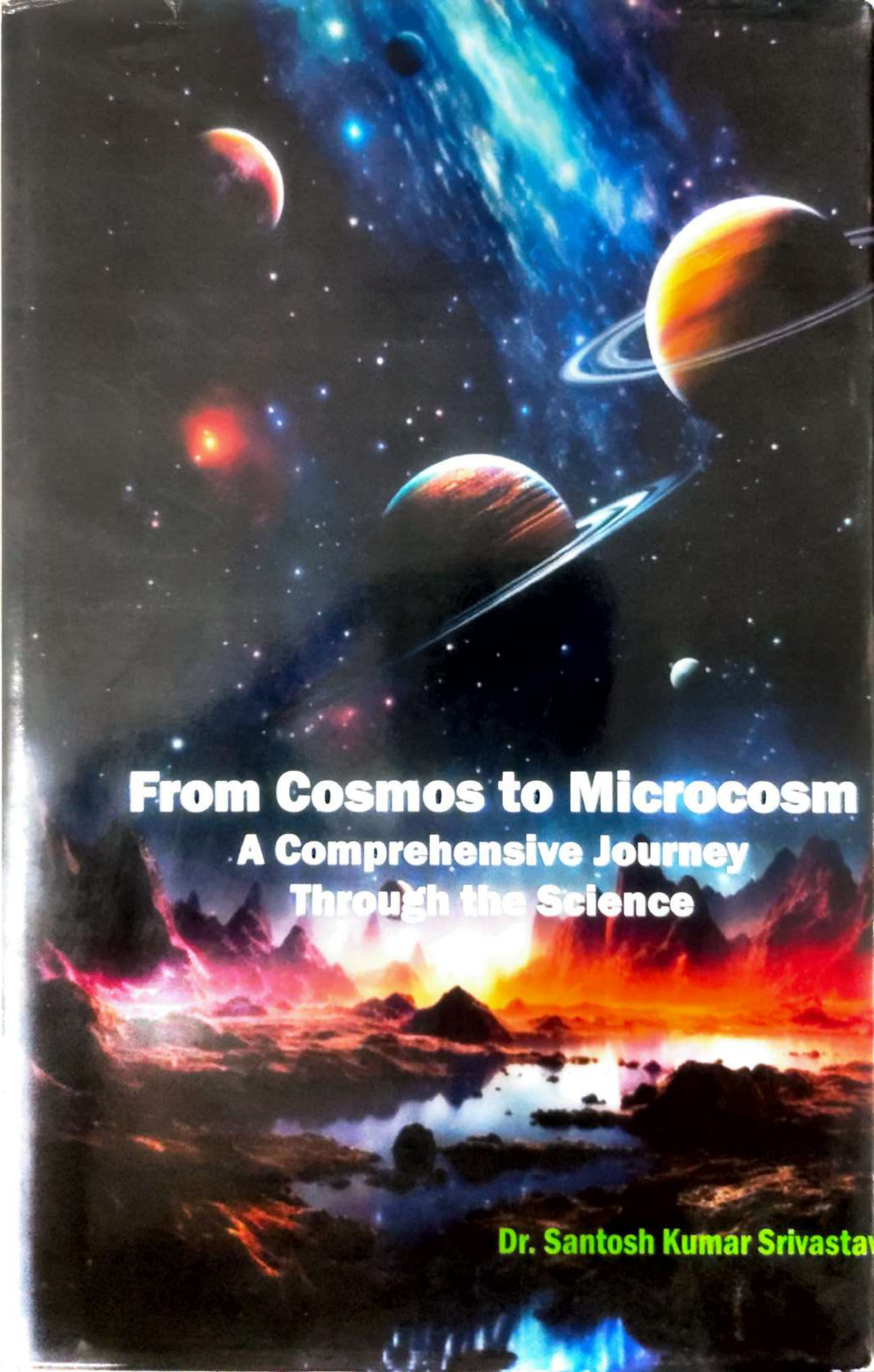
Abstract:

Nature has blessed us with marvelous complex molecules that is impossible for chemists to synthesize in the laboratory.

Thus, plants are regarded as a 'biosynthetic laboratory' for a broad range of chemical compounds called active components that exhibit physiological impacts and provide plants their therapeutic characteristics. An innovative approach by combining several recent discovery methodologies and the novel branches of integrative biology will supply the key to discover various new and novel drugs from plants in the times to come.

Pharmacognosy, one of the ancient scientific branches is now undergoing massive change. Presently plant based drugs are discovered and designed in current model of medicine instead of in the form of galenical preparations or traditional dosage. During the last two decades, as herbal wave persists to rule drug discovery and development, pharmacognosy has gained huge significance. Latest development in extraction, chromatography, hyphenated techniques, screening of natural product and application of biotechnological objects in natural product research has demands good knowledge of pharmacognosy. Swift advancement of biotechnology has paved new paths for pharmacognosist to speed up natural product research. Novel approaches, which are more sensitive and specific compared to conventional one, are becoming popular.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Applications of Organocatalyst in Heterocyclic Compounds

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Abstract:

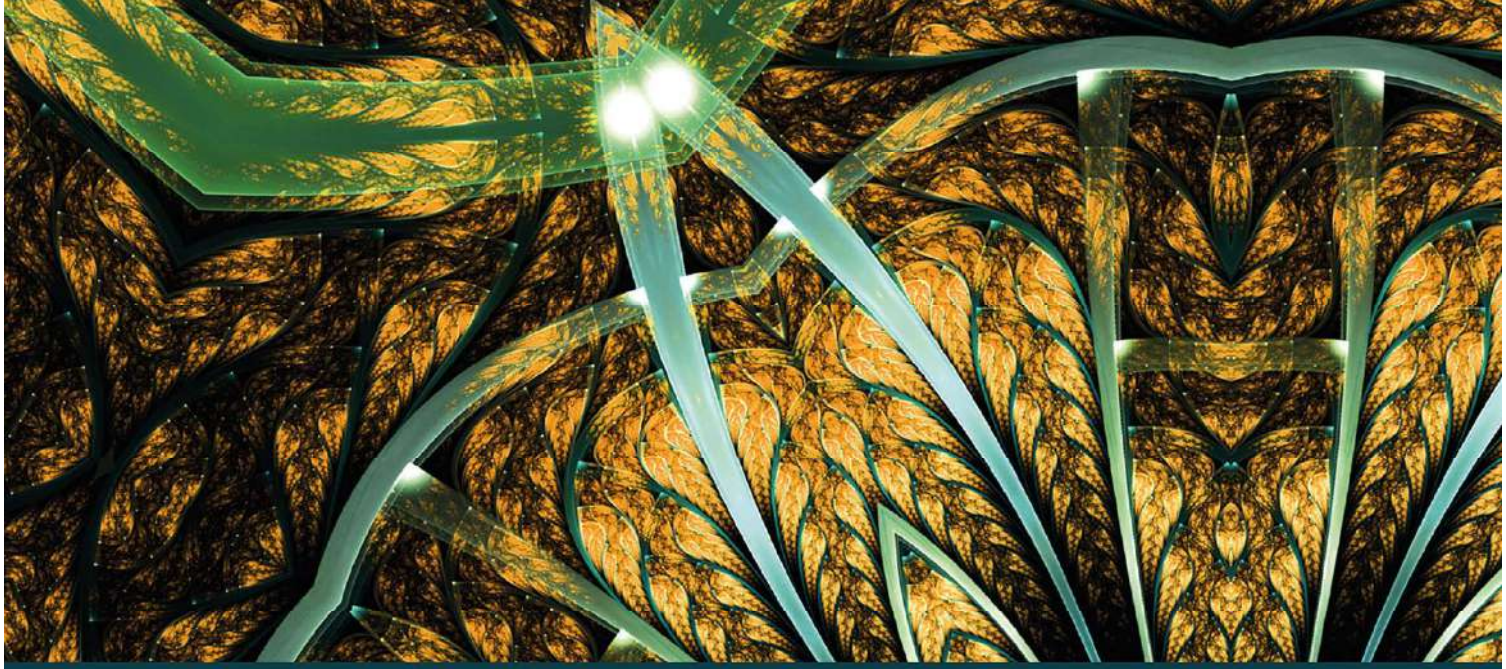
The utilisation of tiny organic molecules as catalysts has attracted chemists in recent times. These molecules known as organocatalysts, exhibit numerous benefits, such as less toxicity, less polluting, and more cost effective compared to the organometallic catalysts that command asymmetric synthesis. This chapter would give a brief insight into some classic reasearch work portraying the benefits of organocatalysis and the different types of compounds synthesized using them.

Can green chemistry play a pivotal role to allow organocatalyst design advance towards sustainable catalysis? What if the fascinating chemistry fostered by more engineered organocatalysts was executed by involving ecofriendly, renewable as well as naturally occurring molecular scaffolds, or synthetic catalysts more regarded towards the goals of green chemistry?

Keywords: *organocatalysis; organocatalyst; green chemistry; chiral; asymmetric molecules.*

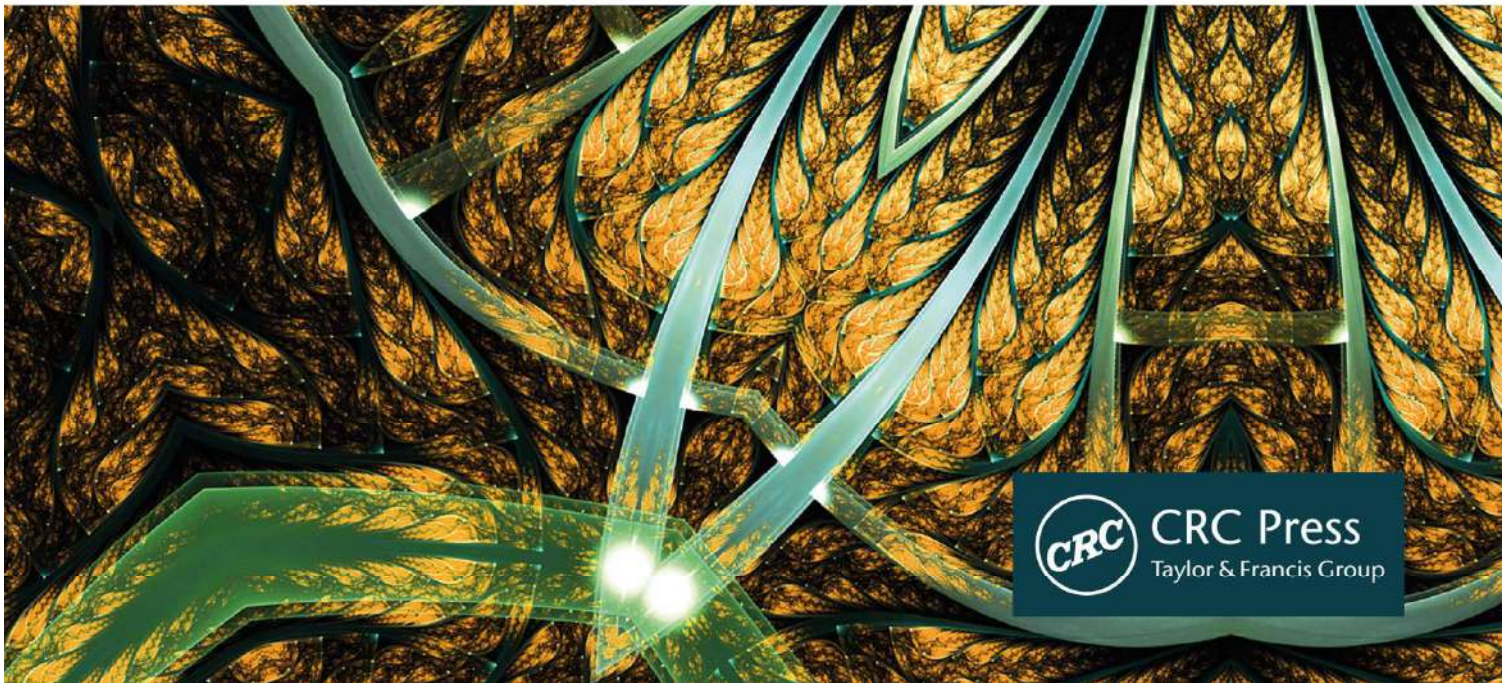
Introduction:

Heterocyclic compounds are the fundamental building blocks of several natural and synthetic biologically important substances. Nitrogen containing heterocyclic compounds are mostly referred as "privileged" molecules due to their significance in the development and manufacturing of novel drugs. This is a known fact that most of the market capturing profitable drugs, such as



NANOTECHNOLOGY FOR SUSTAINABLE AGRICULTURE, FOOD AND ENVIRONMENT

Edited by
Avnesh Kumari, Rajni Garg and Rishav Garg



Nanotechnology for Sustainable Agriculture, Food and Environment

Nanotechnology has the potential to drastically transform the agri-food sector with its significant applications to improve agricultural productivity and the efficiency of agrochemicals. The food sector has benefitted from the inclusion of nanoparticles in food matrixes and the nanoencapsulation of nutraceuticals. Smart packaging materials designed with the help of nanotechnology have been used for increasing the shelf life of stored food products. Nanomaterials have been extensively used for the delivery of important agrochemicals to enhance their bioefficacy, prevent their degradation, and control their release. Various nanomaterials have been explored for remediation of arising environmental issues. Nanotechnology has also made a useful contribution to the utilization of huge agricultural and food wastes for production of valuable products. The existing and emerging applications of nanotechnology will contribute to environmental sustainability.

Nanotechnology for Sustainable Agriculture, Food and Environment has been structured to provide a widespread coverage and up-to-date progress of nanotechnology and its applications in the agri-food sector and environmental remediation. Synthesis of value-added nanomaterials from agri-food wastes and their potential applications in environmental remediation have been explored. In addition, toxicity issues with nanomaterials have also been discussed.

Features:

1. Elaborated information on the use of nanotechnology for sustainable agriculture
2. In-depth study about valorization of agri-food waste
3. An overview of applications of nanotechnology in environmental remediation
4. Toxicity analysis of nanotechnology-based products

We aim to satisfy the need for a reference book for scientists, researchers, academicians and students in nanotechnology, agricultural, food, nutraceuticals, environmental and material sectors.

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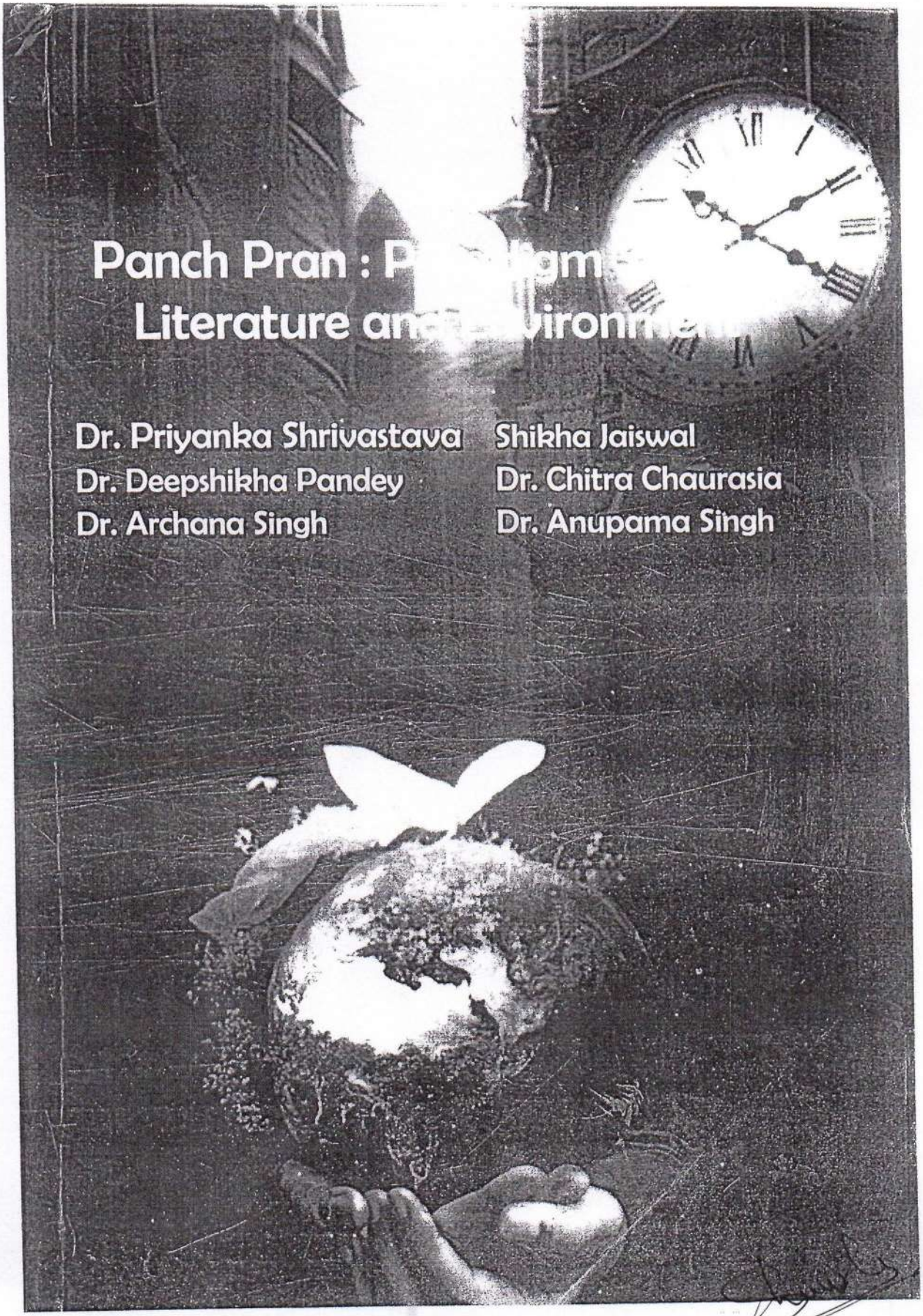
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Environmental Protection: Action Vs Reaction

Dr. Brijesh Kumar Shukla*

1. Introduction

In recent time, with global economic development, the problem of environmental pollution and ecological damagehas become a serious concern. Today India is facing an alarming situation. India ranks the sixth largest and second fastest growing producer of Green House Gases (GHGs) in the world.

The Government of India enacted the Environmental Protection Act of 1986 under Article 253 of the Constitution, which was passed in March 1986,by the Indian Parliament. The main purpose of the Act is to implement the decisions of the United Nations Conference on the Human Environments related to the protection and improvement of the human environment and the prevention of hazards to human beings, other living creatures, plants, and property and heritage. The Act is an *"umbrella"* legislation designed to provide a framework for central government bodies to coordinate the activities of various central and state authorities established under this law, such as the Namami Gange Water Act (Ganga action plan) and the Air Act (Wikipedia, 2016). According to the TERI report India is losing at least 10 % of its natural income due to environmental degradation. The study of the report reveals that the availability of freshwater declined by two-thirds. Indoor and outdoor air pollution results in the nation almost 2.5 million premature deaths. The water requirement of major water-consuming industries such as agro-based, refineries, petrochemicals, and fertilizers has grown 40 times but these are not yet treating the huge wastewater generated. The total sewage generation from

* *Assistant Professor, Department of Geography, Ewing Christian College Prayagraj*

the urban centers has grown six times in the last 60 years (TERI, 2003).In recent years, India's economy has developed rapidly, resulting in damage to the ecological environment. How to protect the environment and, simultaneously, maintain long-term stable developmenthas been the core issue for the future development of Indian society (Zheng et al., 2022). The theory of environmental economics puts forward that the development of the economy depends on the development of the ecological environment, and the balance and coordination between environment and economy should be grasped. Environmental economics emphasizes that while meeting people's growing material needs, it considers the relationship between economic development and the environment, coordinates the relationship between man and nature, and always takes maintaining ecological balance as the precondition for sustainabledevelopment. Environmental responsibility is an essentialrequirement for sustainable development and an effective measure to harmonize economic, social, and environmental development and achieve the goals of sustainable development.

In recent years, India's economy has developed rapidly, resulting in damage to the ecological environment. How to protect the environment and, simultaneously, maintain long-term stable developmenthas been the core issue for the future development of Indian society (Zheng et al., 2022). To cope with the issue of environmental damage, the government, and NGOsplay an important role in protecting the environment, should increase their work in environmental protection, and actively assume environmental responsibility while developing their economies (Klemke-Pitek and Majchrzak,2022).With the increasing awareness of environmental protection in India, the Government and NGOs participating in environmental protection have received significant attention from the public. Taylor et al. (2018) concluded that the fulfillment of environmental responsibility may sacrifice certain economic benefits in the short term, but it guarantees sustainable development in the long term.

2.Objectives

Environmental Protection includes programs that are aimed at reducing risks to the environment from contaminants such as hazardous materials and wastes. Themain objectives are ...

(1) To protect the environment from degradation and take actions to improve the current condition.

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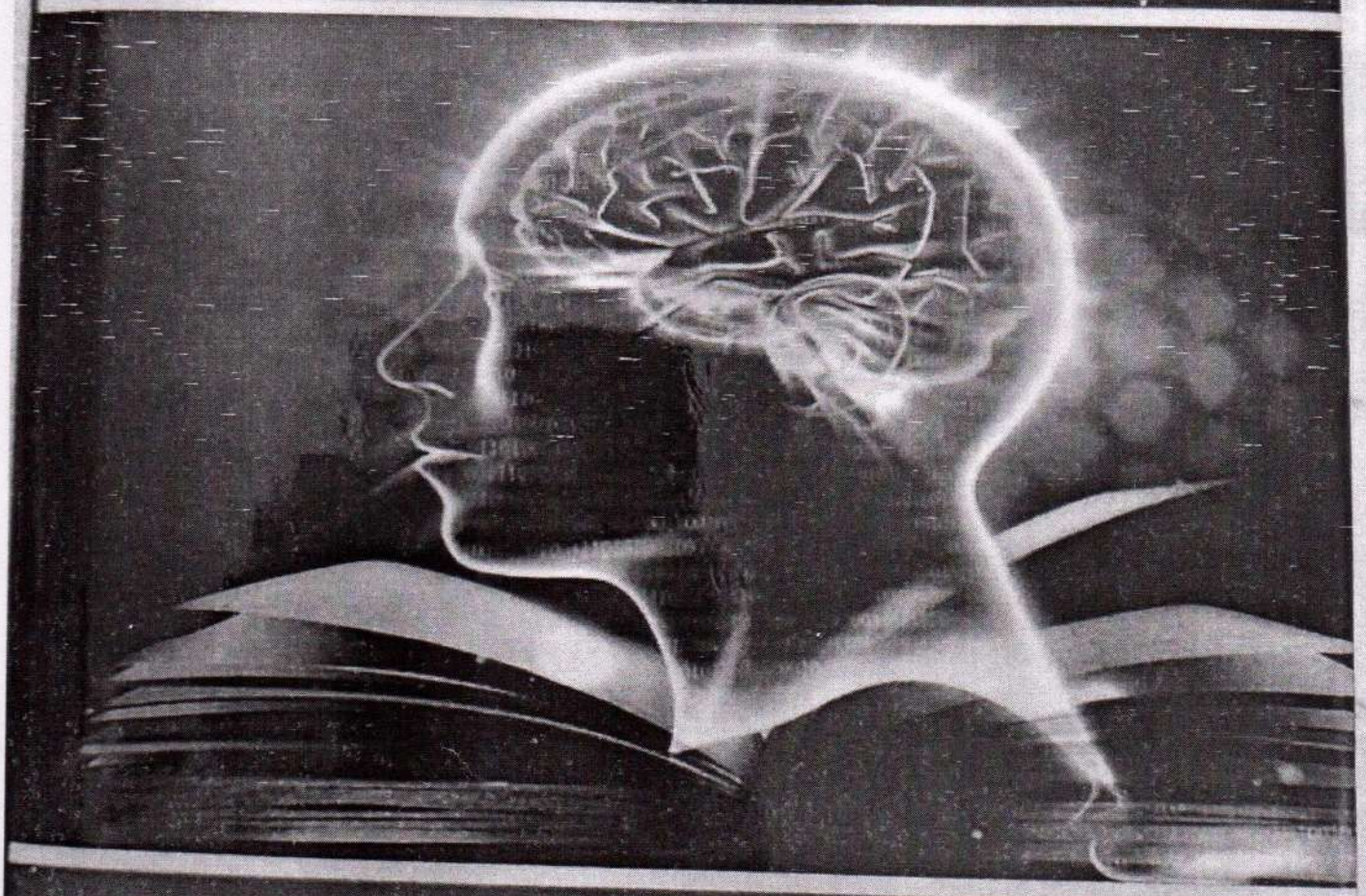

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Rewati Raman Pandey (1942 – 2004)

Early Life (2 April 1942)

Rewati Raman Pandey was born in a Village Mehandipur, district Jaunpur, Uttar Pradesh, India. His father Ramcharan Pandey was a traditional Sanskrit scholar. He has studied up to intermediate in Jai Hind College, Jaunpur and after that he did his graduation with the subject combination of English, Sanskrit and Philosophy and then obtained post-graduate degree in Philosophy and D.Phil. degree from Allahabad University. His dissertation topic was '*The Concept of Prakṛti in Indian Philosophy*' and his research supervisor was S. Datta. He was conferred the degree of Darshanacharya from Sampurnanand Sanskrit University, Varanasi. His first academic assignment was adhoc lecturer in Philosophy Department, Banaras Hindu University (1967) and within six months he was appointed temporary lecture in Philosophy Department, Gorakhpur University. He was awarded DAAD fellowship for higher study in Indology in West Germany (1972-74) and studied German language at the Goethe Institute in Iserlohn. Pandey did a philological study of 'Vedāntasiddhāntamuktāvalī' along with Professor Lambert Schmithausen at the Univer[illegible]es of Münster and Hamburg. He was appointed Lecture (1[illegible]) and later on Reader (1979) and Professor (1987) in the Depa[illegible]ent of Philosophy and Religion, Banaras Hindu University. It wa[illegible] during his headship several national and international conferences and seminars were conducted by the department. Pandey was appointed Visiting Professor to the Jawahar Lal Nehru Chair for Indian Studies at Mahatma Gandhi Institute, Moka, Mauritius (1995-97). He was joint secretary of Akhil Bhartiya Darshan Parishad (1980-86) and

for conducting hermeneutical study of classical Indian texts. He also frequently employs the technique of comparative methodology in discussing and analyzing the relevant philosophical issues and problems.

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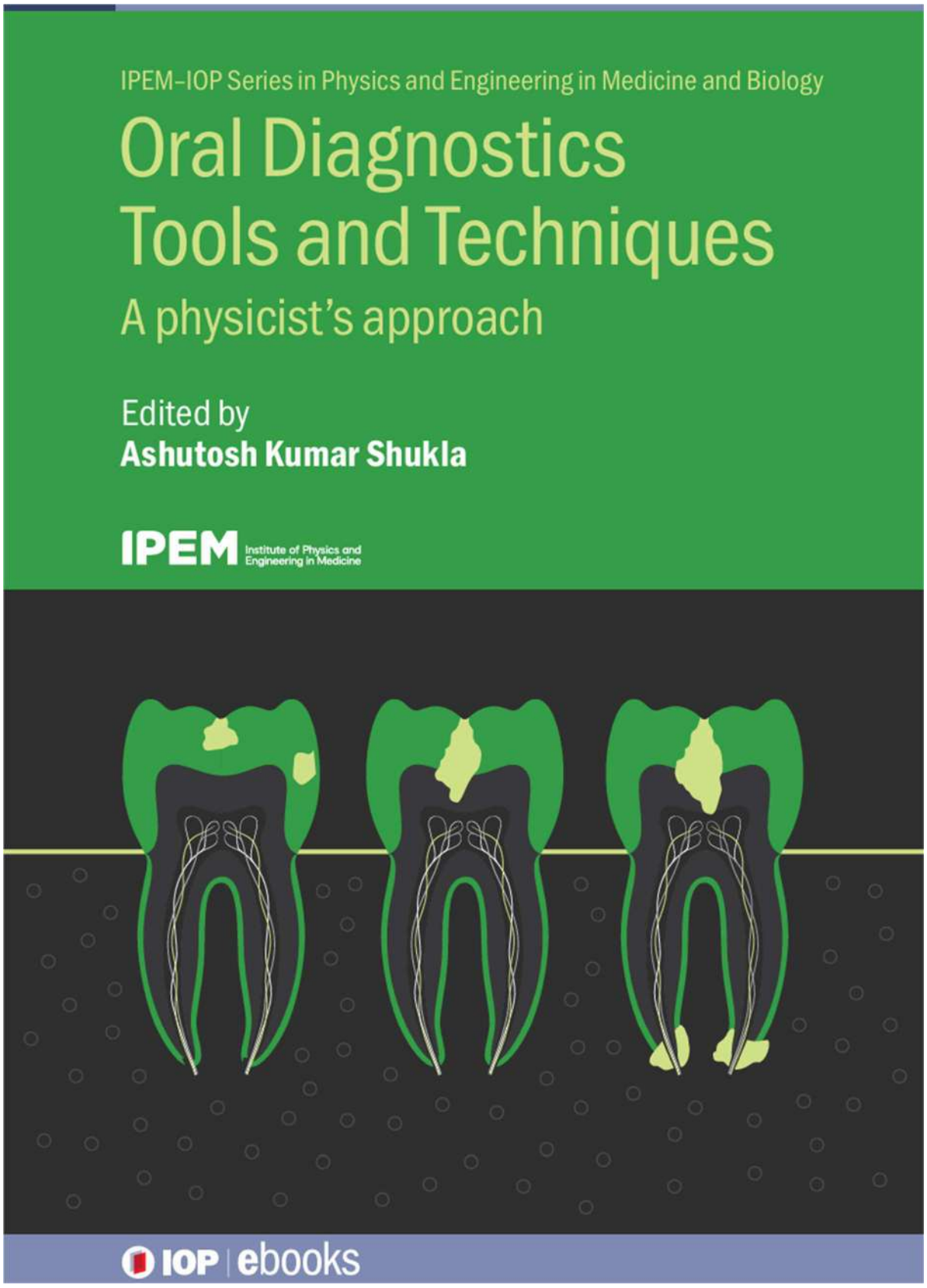
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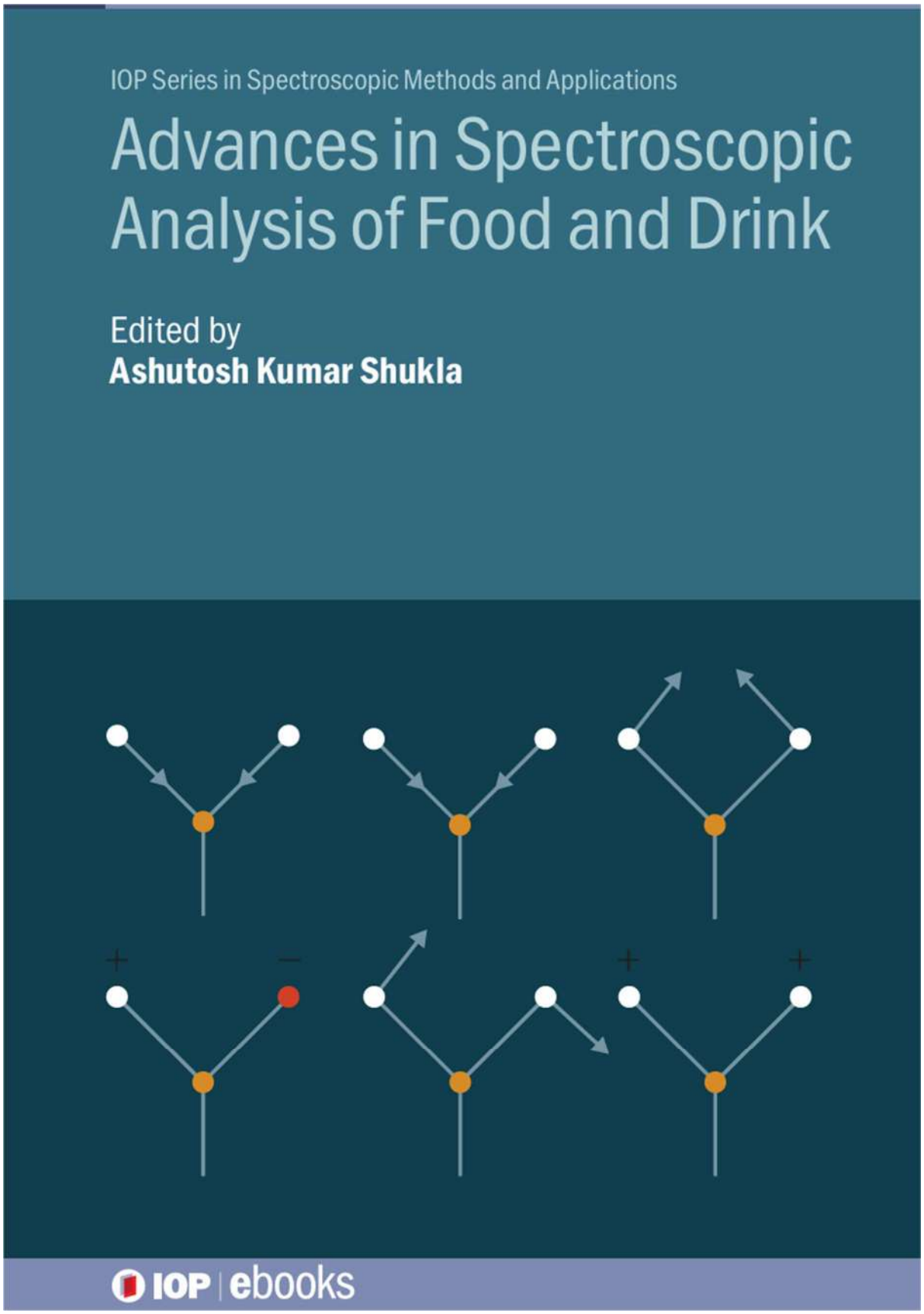
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CHAPTER 5

Investigation of Substrate-effect on BaF_2 Thin Films: A Study of Fractal Nature

Pradip Kumar Priya[1,*], Ram Pratap Yadav[2], Hari Pratap Bhasker[3], Anil Kumar[4] and Kusum Lata Pandey[1]

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Abstract: BaF_2 thin films of thickness 20 nm are prepared using the electron beam evaporation technique (at room temperature) on glass, silicon (Si) as well as aluminum (Al) substrate, respectively. These substrates play a crucial role in the evolution of thin film surface morphology. The thin films grown far from equilibrium have self-affine nature which is reminiscent of fractal behaviour. The surface morphology of films is recorded by atomic force microscopy (AFM). Scaling law analysis is performed on AFM images to confirm that the thin film surfaces under investigation have self-affine nature. The concept of fractal geometry is applied to explore-how different substrates affect the surface morphology of films. The fractal dimension of horizontal as well as vertical sections of AFM images are extracted by applying Higuchi's algorithm. Value of Hurst exponent (H) for each sample is estimated from fractal dimension. It is found to be greater than 0.5 for Al as well as glass substrates, indicating that the height fluctuations at neighboring pixels are correlated positively. However, for Si substrate, its value is less than 0.5 which suggests that the height fluctuations at neighboring pixels are not positively correlated.

Keywords: BaF_2 thin film, Atomic force microscopy (AFM), Self-affine, Hurst exponent, fractal dimension.

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CHAPTER 6

A Detailed Study of Structural, Dielectric and Luminescence Properties of Sm^{3+} Doped $BiFeO_3$ Nanoceramics

Satish Kumar Mandal[1,2,*], Savita[3,4,*], Pradip Kumar Priya[5], Ram Pratap Yadav[6], Hari Pratap Bhasker[7], Raj Kumar Anand[3] and Amreesh Chandra[1]

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Abstract: Observation of at least two coexisting switchable ferroic states viz., ferromagnetic, ferroelectric, and/or ferroelastic at room temperature with promising coupling among order parameters, has made $BiFeO_3$ a highly explored material in the field of multiferroics and/or magnetoelectric multiferroics, which creates the possibility for its application in various technological devices such as spintronics, spin-valve, DRAM, actuators, sensors, solar-cells photovoltaic, *etc.* Intrinsically, its low coupling coefficients, difficulty to prepare in pure phase in bulk, high leakage current, *etc.* have restricted $BiFeO_3$ from technological reliability. However, the effect of doping with iso- and alio-valent ions, nanostructure, thin-film-form and nanoparticles, *etc.*, has been carried out to improve its physical properties by several research groups over the decades. In this chapter, the structural, luminescence, and dielectric properties of samarium (Sm^{3+}) doped $BiFeO_3$ nanoceramics synthesized using a modified gel-combustion route are discussed in detail. The effect of Sm^{3+} doping in $BiFeO_3$ is explored using the X-ray diffraction (XRD) technique. The XRD studies exhibit a possible structural phase transition above Sm^{3+} doping of 15% from rhombohedral (R3c) space group to the orthorhombic (Pbnm) space group. The dielectric study shows interesting behavior accompanied by structural transition. Our study suggests that Sm^{3+}

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CHAPTER 12

Insect Pest Management through Biological Control

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Abstract

Insect pests pose significant challenges to global agriculture, causing substantial economic losses and environmental concerns. Biological control is a sustainable and environmentally friendly approach to managing insect pests, which aims to reduce the reliance on chemical pesticides. The fundamental concepts of biological control, emphasizing the importance of natural enemies and their roles in regulating insect pest populations. It highlights the significance of understanding the ecology of both pests and their natural enemies for effective pest management. The various biological control agents, including parasitoids, predators, and entomopathogenic organisms, and how they can be harnessed for pest control. Recent developments in mass rearing, augmentation, and release techniques are examined, as they play a pivotal role in enhancing the efficacy of biological control. Advancements in genetic and molecular tools that are being

Invasion potential and biology of Cyprinus carpio (common carp)