Preface

Human immunodeficiency virus (HIV), causing impairment of human immune system and inflicting the disease Acquired Immune Deficiency Syndrome (AIDS), is a grave problem that the human race encounters and needs immediate attention to formulate potential treatment strategy against the disease. The HIV epidemic in India has a major impact on the overall spread of HIV in Asia, the Pacific, and around the world. India is the second country only after South Africa in terms of the overall number of people living with the disease. HIV virus has frequent mutation and an infected individual often harbors many variations. The high mutation rate of HIV allows developing resistance against the drugs used to treat it. Development of treatments and vaccines depends not only on knowledge of the complex life cycle of virus, but also on understanding of the difficulty in the management of immune system.

To control HIV, development of the medicines and vaccines will be required in near future. However, poverty and politics are the major obstacles to fight against the disease. Researchers have worked diligently and gained unprecedented knowledge of HIV and its interaction with the immune system. Yet, AIDS pandemic will continue for years to come. In recent years, the mathematically validated therapeutic approach is one of the most significant ways along with the biological, as well as clinical study to control the HIV for social realm of basic human rights. Its study will enable us to administer optimized level of therapies to AIDS patients and would thus be directly befitting to the society. It also provides fundamental methods and techniques for students, who are interested in epidemiological modeling, and guides junior research scientists to some frontiers at the interface of mathematical modeling and public health. It studies the dynamical behavior of the human immune system through drug ingestion under mathematical perceptive.

The book consists of mathematical modeling emphasizing HIV infection to human immune system including its responses to various available drug therapies. As mathematicians, we think that for eradication of the disease, the outline of clinical and experimental observations under the proper mathematical understanding and its application is to be more beneficial towards the society. Here we study
the different drug dynamics to control the HIV disease transmission; also we study the ultimate goal of the expected time to extinction of the disease through mathematical analysis via stochastic approach. We also studied feedback mechanism in the bidirectional disease transmission dynamics which plays a significant role in combating against the infection.

Contents of the book are organized considering the process of cell biology of disease progression in HIV infection and different drug dynamics. The book helps to investigate how specific antiviral treatment can affect the immune response, that is, whether this treatment can predominantly reduce the viral load and in another sense, how it controls the disease progression in a long-term treatment of HIV infected patients. To avoid complications of the results, further analysis is performed to investigate the mathematical models with the help of optimal control theory. The effect of perfect adherence to antiretroviral therapy with respect to basic mathematical model of HIV would be introduced elaborately by impulsive differential equations. The book also studies on how we shall be able to determine the threshold value of the drug dosage and the dosing interval for which the disease can be eradicated by safe drug dosage. Delay dynamics in different variants is also discussed in this book. It is also analyzed how the delay affects the qualitative properties of the model dynamics through drug concentration during therapy. Mathematical modeling with control therapeutic approach for understanding the extinction of disease is quite significant. But under deterministic model this approach is not viable. With a view to obtain the feasibility, stochastic approach might play an escalating role in estimating the expected time to extinction of the disease in epidemiological system. In this book, we studied mathematically to find out recovery of the disease after a certain period with therapeutic control approach and later by incorporating stochastic scheme we also estimated the expected time to extinction of the disease. This book contains a mathematical-stochastic-numerical approach and analysis of different models of HIV infection with the help of control system techniques. Analytical and numerical studies and their results in treatment management would generate insights about the state of healthiness of human system, the effects of drugs including interruptions caused by HAART, IL2, DC-based immunization etc., which provides CTL-mediated control of HIV infection. This book can help to enhance the consciousness of the importance of mathematical modeling in the study of HIV/AIDS transmission and in connecting the gap between mathematical modelers in basic theoretical research, medical scientists and public health policy makers working in health research institutes. This book will appeal to undergraduate and postgraduate students and biomathematicians who are studying and working in the field of mathematical modeling on infectious diseases. Social workers who are working in the field of HIV will get prior knowledge about application of drugs to the HIV/AIDS infected patients. This book will serve as an additional textbook for graduate students and researchers in applied mathematics, health informatics, applied statistics, and qualitative public health.

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