Preface

All branches of basic and applied sciences deal with experimental approaches. In this age, enormous data are generated from the experiments. Sometimes, experiments and the approach to doing experiments are not properly guided by scientific methods. This consumes resources and does not lead to a meaningful understanding of systems. In keeping with this trend, experimenters use computational resources to solve their immediate needs without understanding the basic approach. The correct approach, however, is to properly design experiments by applying statistical knowledge. Mere use of statistical terms and their analysis, without knowledge of statistics, gives the user a black box concept. It is satisfying and fun to appropriately exploit statistics, which explains why, what, how, or when something happens, and to use a statistical experimental approach to obtain corresponding data, complete analysis, interpret results, or make predictions.

This book intends to engage the reader in developing a foundation for the statistical experimental approach. This is true for any branch of science or engineering.

The book addresses the problem of optimization of bioprocess systems in its entirety. There are a number of books written by statisticians who address the problem of mathematical optimization, but there is a void as far as the experimental optimization of biological systems employing statistical techniques is concerned. The optimization of biological systems requires a thorough understanding of the system and the application of the appropriate mathematical and statistical tools; this book fills this void.

The book is organized into seven chapters that emphasize the foundations and applications of biological systems.

Chapter 1 discusses the complex nature of biological systems and the need for optimization. The advantages and disadvantages of non-statistical methods of optimization and the rationale for statistical methods of optimization are presented. In Chapter 2, the traditional one-variable-at-a-time approach to optimization is reviewed with suitable examples. Chapter 3 deals with experimental designs. The planning of an experiment starts with the setting of goals or objectives and identifying the process variables. Then an appropriate screening design is chosen to identify the important variables, which have a profound effect on the outcome. The process must be made robust. Response surface methodology is then employed to maximize (or minimize) a response and to reduce variation by locating a region where the bioprocess is easier to manage. Then regression modelling is done to obtain a precise model, which would quantify the dependence of the response on the process variables. Chapter 4 details the statistical analysis and optimization of different experimental designs, the results of which are used to determine

the important variables and optimum settings. The different optimization techniques employed to determine the optimum levels of the process variables for both single- and multiple-response systems are described. Chapters 5 and 6 outline less frequently employed experimental designs, like the Evolutionary Operation Programmes and Taguchi's designs, respectively. Chapter 7 describes the concept of hybrid experimental designs, which shows better optimization of data obtained from biological systems, using the essence of genetic algorithm. The entire book is illustrated with real-life bioprocess optimization problems and their solutions and exercise problems for practice. The book contains useful appendix, and an index.

Tapobrata Panda
Indian Institute of Technology Madras

R. Arun Kumar
Indian Institute of Technology Madras

Thomas Théodore
Siddaganga Institute of Technology
Tumkur