

# Acknowledgements

Researchers do not need to be statisticians to perform quality research, but they do need to understand the basic principles of statistical analysis. This book represents the most useful approaches learned through my years of experience in designing the statistically based studies in microbial death-rate kinetics, skin biotechnology, and clinical trials performed by my company, BioScience Laboratories, Inc.

I am truly grateful to my co-workers at BioScience, who kept the business running while I wrote and rewrote the chapters in this book, in particular, my very capable and supportive wife, Marsha Paulson, Vice-President of BioScience Laboratories, Inc. I am especially indebted to John Mitchell, Director of Quality Assurance, for his many hours of challenging my assumptions, utilizing his vast knowledge of microbiology, and editing this work. Tammy Anderson provided valuable assistance in the development of this book by typing and retyping it, making format changes, editing, creating figures and diagrams, and basically, managing the entire book development process. Her abilities are astounding.

Finally, I thank the staff at Springer for their patience, flexibility, professionalism, and quality concerns.

|     |                                                      |     |
|-----|------------------------------------------------------|-----|
| 1   | Introduction                                         | 1   |
| 2   | Statistical Analysis                                 | 2   |
| 3   | One-Sample Statistical Tests                         | 3   |
| 4   | Two-Sample Statistical Tests                         | 4   |
| 5   | Statistical Tests: Normal Distribution               | 5   |
| 6   | Statistical Tests: Non-Normal Distribution           | 6   |
| 7   | Statistical Tests: Chi-Square                        | 7   |
| 8   | Statistical Tests: Fisher's Exact Test               | 8   |
| 9   | Statistical Tests: McNemar's Test                    | 9   |
| 10  | Statistical Tests: Mantel-Haenszel Test              | 10  |
| 11  | Statistical Tests: Logistic Regression               | 11  |
| 12  | Statistical Tests: Poisson Regression                | 12  |
| 13  | Statistical Tests: Cox Proportional Hazards Model    | 13  |
| 14  | Statistical Tests: Survival Analysis                 | 14  |
| 15  | Statistical Tests: Discriminant Analysis             | 15  |
| 16  | Statistical Tests: Principal Component Analysis      | 16  |
| 17  | Statistical Tests: Factorial Analysis of Variance    | 17  |
| 18  | Statistical Tests: Analysis of Covariance            | 18  |
| 19  | Statistical Tests: Regression Analysis               | 19  |
| 20  | Statistical Tests: Correlation Analysis              | 20  |
| 21  | Statistical Tests: Non-Parametric Tests              | 21  |
| 22  | Statistical Tests: Sign Test                         | 22  |
| 23  | Statistical Tests: Rank Sum Test                     | 23  |
| 24  | Statistical Tests: Friedman Two-Way ANOVA            | 24  |
| 25  | Statistical Tests: Kruskal-Wallis Test               | 25  |
| 26  | Statistical Tests: Scheffé's Test                    | 26  |
| 27  | Statistical Tests: Dunnett's Test                    | 27  |
| 28  | Statistical Tests: Bonferroni Test                   | 28  |
| 29  | Statistical Tests: Sidak-Bonferroni Test             | 29  |
| 30  | Statistical Tests: Holm-Sidak Test                   | 30  |
| 31  | Statistical Tests: False Discovery Rate              | 31  |
| 32  | Statistical Tests: Benjamini-Hochberg Test           | 32  |
| 33  | Statistical Tests: Benjamini-Yekutieli Test          | 33  |
| 34  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 34  |
| 35  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 35  |
| 36  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 36  |
| 37  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 37  |
| 38  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 38  |
| 39  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 39  |
| 40  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 40  |
| 41  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 41  |
| 42  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 42  |
| 43  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 43  |
| 44  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 44  |
| 45  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 45  |
| 46  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 46  |
| 47  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 47  |
| 48  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 48  |
| 49  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 49  |
| 50  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 50  |
| 51  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 51  |
| 52  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 52  |
| 53  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 53  |
| 54  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 54  |
| 55  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 55  |
| 56  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 56  |
| 57  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 57  |
| 58  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 58  |
| 59  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 59  |
| 60  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 60  |
| 61  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 61  |
| 62  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 62  |
| 63  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 63  |
| 64  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 64  |
| 65  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 65  |
| 66  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 66  |
| 67  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 67  |
| 68  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 68  |
| 69  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 69  |
| 70  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 70  |
| 71  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 71  |
| 72  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 72  |
| 73  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 73  |
| 74  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 74  |
| 75  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 75  |
| 76  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 76  |
| 77  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 77  |
| 78  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 78  |
| 79  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 79  |
| 80  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 80  |
| 81  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 81  |
| 82  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 82  |
| 83  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 83  |
| 84  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 84  |
| 85  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 85  |
| 86  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 86  |
| 87  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 87  |
| 88  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 88  |
| 89  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 89  |
| 90  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 90  |
| 91  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 91  |
| 92  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 92  |
| 93  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 93  |
| 94  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 94  |
| 95  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 95  |
| 96  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 96  |
| 97  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 97  |
| 98  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 98  |
| 99  | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 99  |
| 100 | Statistical Tests: Benjamini-Hochberg-Yekutieli Test | 100 |