

# Contents

Preface xiii  
List of Contributors xv  
List of Reviewers xix

## I

### GENERAL

#### 1. Ethical Considerations and Regulatory Issues

MARILYN J. BROWN AND KATHLEEN L. SMILER

Introduction 3  
Ethical Concepts 4  
Ethical Challenges 14  
Institutional Animal Welfare Oversight 20  
Regulations and Non-regulatory Considerations 21  
Conclusion 27  
References 27

#### 2. Anesthesia and Analgesia

PATRICK A. LESTER, RASHIDA M. MOORE,  
KATHERINE A. SHUSTER, AND DANIEL D. MYERS

Pre-anesthetic Preparation 34  
Controlled Substances 34  
Pharmacology 35  
Anesthesia Circuits 44  
Anesthesia Monitoring and Support 46  
Surgical Anesthesia 49  
Post-operative Monitoring and Pain Assessment 50  
References 53

#### 3. Clinical Biochemistry and Hematology

IDA M. WASHINGTON AND GERALD VAN HOOSIER

Introduction 59  
Clinical Biochemistry 59  
Rabbit 70  
Guinea Pig 76  
Hamster 80  
Other Rodents 85  
Hematology 90  
Rabbit 97  
Guinea Pig 102  
Hamster 104  
Other Rodents 106  
References 110

#### 4. Euthanasia and Necropsy

MIHAI GAGEA-IURASCU AND SUZANNE CRAIG

Introduction 117  
Euthanasia 117  
Necropsy 123  
Pathology Considerations 134  
References 136

#### 5. Zoonoses and Occupational Health

DAVID W. BRAMMER

Introduction 142  
Viral Diseases 142  
Rickettsial Diseases 144  
Chlamydial Diseases 146  
Bacterial Diseases 146  
Fungal Diseases 149  
Cestode Infections 150  
Arthropod Infections 150  
Allergies 150  
Prevention of Allergy and Zoonotic Disease 151  
References 151

## II

### RABBITS

#### 6. The Domestic Rabbit, *Oryctolagus Cuniculus*: Origins and History

KATHERINE A. NAFF AND SUZANNE CRAIG

Introduction and Background 157  
Phylogeny and Taxonomy 158  
Geographic Origins and Diversity 159  
Domestication and Breed Development 160  
Ecology and Conservation 161  
References 162

#### 7. Rabbit Genetics and Transgenic Models

NEIL D. CHRISTENSEN AND XUWEN PENG

Rabbit Genetics 165  
Transgenic Rabbits 174  
Conclusions 185  
References 185

## 8. Anatomy, Physiology, and Behavior

JOANNE SOHN AND MARCELO A. COUTO

Introduction	195
External Features	196
Osteology	197
Oral Cavity	199
Abdominal Viscera	200
Urogenital System	203
Thoracic Viscera	207
Brain and Spinal Cord	208
Metabolism	211
Behavior	211
Acknowledgment	213
References	213

## 9. Rabbit Colony Management and Related Health Concerns

ROBERT H. QUINN

Introduction	218
Laboratory Management	218
Breeding	229
Nutrition	232
Nutritionally Related Diseases	236
References	238

## 10. Basic Experimental Methods in the Rabbit

CYNTHIA A. PEKOW

Introduction	243
Handling and Restraint	244
Sampling Techniques	246
Compound Administration	250
Specialized Research Techniques	254
References	256

## 11. Polyclonal Antibody Production

HAROLD F. STILLIS

Introduction	259
The Immunogen	260
Immunogen Dose	261
Route of Immunization	262
Immunization Schedule	263
Adjuvants	263
Summary	270
References	270

## 12. Toxicity and Safety Testing

DEBRA KIRCHNER AND SUSAN HENWOOD

Introduction	275
Toxicity Testing	276
Safety Testing	280
Metabolism and Toxicokinetics	294
Acknowledgments	296
References	296

## 13. Bacterial Diseases

DAVID DELONG

Introduction	303
Pasteurellosis	303
Enterotoxemia	314
Tyzzler's Disease	318
Colibacillosis	321
Salmonellosis	326
Staphylococcosis	328
Treponematosi	331
Necrobacillosis	335
Listeriosis	337
Tuberculosis	339
Tularemia	341
Proliferative Enteropathy	343
Miscellaneous Bacterial Diseases	344
References	348

## 14. Viral Diseases

THEA BRABB AND RONALD F. DI GIACOMO

Introduction	365
DNA Virus Infections	368
RNA Virus Infections	386
References	401

## 15. Parasitic Diseases

STACY PRITT, KIMBERLEY COHEN, AND HEATHER SEDLACEK

Introduction	415
Protozoa	416
Arthropods	428
Helminths	435
References	443

## 16. Rabbit Neoplasia

PEGGY T. TINKEY, RAJESH K. UTHAMANTHIL, AND STEVEN H. WEISBROTH

Introduction	448
Neoplasms of <i>Oryctolagus cuniculus</i>	458
Neoplasms of <i>Sylvilagus</i>	487
Neoplasms of <i>Lepus</i>	489
References	489

## 17. Mycoses and Non-Infectious Diseases

KRISTIE BROCK, LAURA GALLAUGHER, VALERIE K. BERGDALL, AND ROBERT C. DYSKO

Introduction	504
Mycotic Diseases	504
Non-Infectious Diseases	505
References	523

18. The Rabbit as an Experimental Model

TANYA H. BURKHOLDER, GARRY LINTON, ROBERT E. HOYT, JR., AND  
RICHARD YOUNG

Introduction 530  
 Cardiovascular Diseases 530  
 Ophthalmic Diseases 537  
 Central Nervous System Diseases 542  
 Respiratory Diseases 542  
 Urogenital Diseases 545  
 Gastrointestinal Diseases 546  
 Musculoskeletal Diseases 548  
 Multisystemic Diseases 550  
 Acknowledgments 552  
 References 552

III

GUINEA PIGS

19. Taxonomy and History

STACY PRITT

Introduction 563  
 Taxonomy and Geographical Distribution 564  
 Origin and Domestication 566  
 Genetics 568  
 References 572

20. Anatomy, Physiology, and Behavior

MAUREEN HARGADEN AND LAURA SINGER

Introduction 576  
 External Anatomy 576  
 Musculoskeletal System 578  
 Digestive System 581  
 Cardiovascular System 583  
 Pulmonary System 586  
 Genitourinary System 590  
 Nervous System 596  
 Special Senses 596  
 Behavior 598  
 References 599

21. Management, Husbandry, and Colony Health

VINCENT C. GRESHAM AND VICKY L. HAINES

Introduction 603  
 Handling 604  
 Housing 604  
 Reproduction and Breeding 611  
 Nutrition 612  
 Colony Health 614  
 Record Keeping 615  
 References 617

22. Basic Experimental Methods

RICHARD B. HUNEKE

Introduction 621  
 Handling and Restraint 621  
 Sampling Techniques 622  
 Compound Administration 624  
 Specialized Research Techniques 624  
 References 632

23. Infectious Diseases

THEA BRABB, DENISE NEWSOME, ANDREW BURICH, AND  
MARTHA HANES

Introduction 638  
 Viral Diseases 638  
 Bacterial Infections 645  
 Fungal Infections 661  
 Protozoa Infections 665  
 Parasitic Infections 669  
 References 676

24. Non-Infectious Diseases

BRUCE H. WILLIAMS

Introduction 686  
 Cardiovascular System 686  
 Respiratory System 687  
 Gastrointestinal System 688  
 Urinary System 691  
 Endocrine System 692  
 Reproductive System 693  
 Musculoskeletal System 696  
 Integumentary System 698  
 Special Senses 700  
 Hematolymphatic System 700  
 Multisystemic Conditions 701  
 References 702

25. Guinea Pigs as Experimental Models

DOUGLAS K. TAYLOR AND VANESSA K LEE

Introduction 705  
 Models of Disease 706  
 References 728

IV

HAMSTERS

26. Taxonomy and History

GERALD D. SMITH

Taxonomy 747  
 Geographical Distribution 747  
 Origin and Domestication 748  
 Genetics 750  
 Acknowledgments 751  
 References 751

CONTENTS

27. Anatomy, Physiology, and Behavior

KATHLEEN A. MURRAY

Introduction 753  
External Features 753  
Musculoskeletal System 754  
Digestive System 754  
Circulatory System 756  
Pulmonary System 757  
Genitourinary System 757  
Nervous System 760  
Special Senses 761  
Behavior 762  
References 762

28. Management, Husbandry, and Colony Health

GUY B. MULDER

Introduction 765  
Housing 765  
Environmental Conditions 766  
Nutrition 768  
Breeding 770  
Colony Health 771  
Record Keeping 774  
References 775

29. Biomedical Research Techniques

JERALD SILVERMAN

Introduction 779  
General Non-Surgical Procedures 780  
Injections and Intubations 783  
Biological Specimen Collections 786  
Other Surgical Procedures 789  
References 793

30. Bacterial and Fungal Diseases

CRAIG S. FRISK

Introduction 798  
Bacterial Diseases 798  
Fungal Diseases 816  
References 817

31. Viral Diseases

AMY CASSANO, SKYE RASMUSSEN, AND FELIX R. WOLF

Introduction 822  
DNA Viruses 822  
RNA Viruses 828  
Miscellaneous Viruses 833  
References 833

32. Parasitic Diseases

HOLLY N. BURR, LEE-RONN PALUCH, GORDON S. ROBLE, AND  
NEIL S. LIPMAN

Introduction 839  
Protozoa 840

Nematodes 847  
Cestodes 854  
Arthropods 857  
References 863

33. Non-Infectious Diseases

BRIAN KAROLEWSKI, THOMAS W. MAYER, AND GAYE RUBLE

Introduction 867  
Diseases Associated with Aging 867  
Nutritional Disorders 871  
Genetic, Traumatic, Environmental and Other Non-Infectious  
Diseases 871  
Neoplasms 872  
References 872

34. The Experimental Use of Syrian Hamsters

HELEN VALENTINE, ERIN K. DAUGHERITY, BHUPINDER SINGH, ANI  
KIRK J. MAURER

Introduction 876  
Cancer Research 876  
Metabolic Diseases 879  
Non-Cancerous Respiratory Diseases 883  
Cardiovascular 885  
Infectious Disease Research 887  
Other Models 894  
References 898

35. The Chinese or Striped-Back Hamster

WILLIAM P. FEENEY

Introduction 907  
Biology 908  
Care and Husbandry 909  
Cytogenetics and Fetal Development 910  
Diseases 910  
Research Uses 913  
Summary 918  
References 919

36. The European Hamster

JUDY FENYK-MELODY

Taxonomy 923  
History 923  
Biology 924  
Behavior 928  
Diseases 929  
Management, Husbandry, and Colony Health 930  
Experimental Methodology 930  
Use in Biomedical Research 930  
References 931

37. Other Hamsters

BETH A. BAUER AND CYNTHIA BESCH-WILLIFORD

Introduction 935  
*Phodopus sungorus* (Djungarian Hamster) 935  
*Mesocricetus brandti* (Turkish Hamster) 939

*Cricetulus migratorius* (Armenian Hamster) 941  
*Mesocricetus newtoni* (Romanian Hamster) 942  
 References 943

## V

## CHINCHILLAS

## 38. Taxonomy and History

BRENT J. MARTIN

Introduction 949  
 Taxonomy 949  
 History 951  
 References 952

## 39. Anatomy, Physiology, and Behavior

LEANNE C. ALWORTH AND STEPHEN B. HARVEY

Introduction 955  
 External Features 955  
 Unique Biological Characteristics 957  
 Behavior 963  
 References 965

## 40. Management, Husbandry, and Colony Health

STEPHEN I. LEVIN, DIANA M.P. BERGER, AND TRACY L. GLUCKMAN

Introduction 967  
 Housing Systems 967  
 Environmental Conditions 969  
 Nutrition 970  
 Breeding 971  
 Colony Health 973  
 Record Keeping 973  
 References 975

## 41. Basic Experimental Methods

CHARLIE C. HSU, JELEEN A. BRISCOE, AND ANGELA B. KEFFER

Introduction 977  
 Handling and Restraint 978  
 Mechanical Methods 980  
 Sampling Techniques 982  
 Compound Administration 988  
 Specialized Research Techniques 990  
 References 990

## 42. Diseases and Veterinary Care

JOHN N. NORTON AND RANDALL P. REYNOLDS

Introduction 993  
 Infectious Diseases 994  
 Gastrointestinal and Metabolic Diseases 1000  
 Traumatic Lesions 1001  
 Management-Related Disorders 1002  
 Neoplastic Diseases 1002

Miscellaneous Conditions 1002  
 References 1006

## 43. Chinchillas as Experimental Models

LISA MARTIN

Introduction 1009  
 Models Related to Aural Disease 1010  
 Models Related to Hearing Loss 1017  
 Future of Chinchilla Models 1026  
 References 1026

## VI

## OTHER RODENTS

## 44. Degu

LESLEY A. COLBY, HOWARD G. RUSH, MEGAN M. MAHONEY AND THERESA M. LEE

Introduction 1032  
 History and Taxonomy 1032  
 Anatomy, Physiology, and Behavior 1033  
 Management, Husbandry, and Colony Health 1038  
 Handling and Restraint 1043  
 Sampling Techniques 1044  
 Compound Administration 1044  
 Anesthesia and Analgesia 1044  
 Euthanasia and Necropsy 1046  
 Diseases 1046  
 The Degu as an Experimental Model 1047  
 References 1049

## 45. Naked Mole Rat

ROCHELLE BUFFENSTEIN, THOMAS PARK, MARTHA HANES, AND JAMES E. ARTWOHL

History 1055  
 Taxonomy 1056  
 General Description 1056  
 Natural Habitat 1057  
 Behavior 1058  
 Reproductive Behavior 1059  
 General Physiology 1060  
 Anatomy and Physiology of Organ Systems 1061  
 Aging 1065  
 Husbandry 1066  
 Colony Health 1067  
 Use in Research 1069  
 References 1071

## 46. Deer Mice, White-Footed Mice, and their Relatives

PETER C. SMITH, JODI A. CARLSON SCHOLZ, AND STEVEN R. WILSON

Introduction 1075  
 Biology 1078  
 Husbandry 1080  
 Captive Breeding 1081

CONTENTS

Diseases 1081  
Anesthesia/Analgesia 1084  
References 1085

47. Dormouse

JOHN P. LONG AND CHERI L. WEST

Introduction 1089  
Taxonomy and History 1089  
Anatomic Characteristics 1090  
Husbandry 1090  
Nutrition 1091  
Housing 1091  
Environmental Conditions 1092  
Handling 1092  
Breeding 1092  
Diseases and Zoonoses 1092  
Colony Health Monitoring 1092  
Experimental Applications 1092  
Biomethodology 1093  
References 1093

48. Kangaroo Rat

DENISE M. NEWSOM AND GERALD L. VAN HOOSIER, JR.

Introduction 1095  
Biology 1097  
Diseases 1100  
Use in Research 1101  
Laboratory Care 1102  
References 1103

49. Cotton Rat

JOSEPH F. CURLEE AND DALE M. COOPER

Introduction 1105  
Biology 1106  
Husbandry 1108  
Diseases 1109  
Experimental Methods 1110  
Use in Research 1110  
Acknowledgments 1111  
References 1111

50. Pocket Gopher

M. SUSAN DEVRIES

Introduction 1115  
Biology 1119  
Diseases 1122  
References 1123

51. White-Tailed Rat

BETH A. BAUER AND CYNTHIA L. BESCH-WILLIFORD

Introduction 1125  
Taxonomy, History, and Genetics 1125  
Anatomy, Physiology, and Behavior 1126  
Management, Husbandry, and Colony Health 1127

Basic Experimental Methods 1127  
Diseases and Veterinary Care 1128  
Experimental Models 1129  
References 1129

52. Gerbils

MARGARET BATCHELDER, LYNN S. KELLER, MARY BALL SAUER,  
AND WANDA L. WEST

Introduction 1132  
Taxonomy and History 1132  
Anatomy, Physiology, and Behavior 1133  
Management, Husbandry, and Colony Health 1138  
Basic Experimental Methods 1141  
Veterinary Care and Diseases 1144  
Gerbils as Experimental Models 1146  
References 1149

53. Egyptian Fat-Tailed Jird

STEPHEN A. FELT, NANCY L. MERRILL, FADY I. GUIRGUIS, AND  
HUSSEIN I. HUSSEIN

Introduction 1158  
Anatomy, Physiology, and Behavior 1159  
Management, Husbandry, and Colony Health 1160  
Diseases 1164  
Anesthesia/Analgesia, Euthanasia, and Necropsy 1167  
Use in Research 1167  
Basic Experimental Methods 1168  
References 1169

54. Sand Rat

RONY KALMAN, EHUD ZIV, GALILA LAZAROVICI, AND  
ELEAZAR SHAFRIR

Introduction 1171  
Selection of Reliable Diets and *Psammomys* Lines for  
Diabetes Research 1172  
Metabolic Efficiency 1173  
Morphology, Physiology, Breeding Performance, and  
Husbandry 1176  
The Basis of Diabetes in *Psammomys* 1179  
The Relevance of *Psammomys* to Diabetes Research 1185  
The Genetic Basis of *Psammomys* Diabetes 1186  
Worldwide Research Using *Psammomys* 1187  
Complications of Diabetes in *Psammomys* 1187  
Concluding Remarks 1188  
References 1188

VII

FORMULARY AND NORMATIVE  
VALUES

55. Formulary

SEAN MAGUIRE AND C. TERRANCE HAWK

Introduction 1193  
Rabbit (*Oryctolagus cuniculus*) 1194

## CONTENTS

Guinea Pig ( <i>Cavia porcellus</i> )	1208
Hamster ( <i>Mesocricetus auratus</i> )	1217
Degu ( <i>Octodon degus</i> )	1222
Other Species	1224
References	1225

Hamsters	1234
Gerbils ( <i>Meriones unguiculatus</i> )	1236
Chinchillas ( <i>Chinchilla laniger</i> )	1237
Other rodents	1238
References	1243

### 56. Normative Values

JOLAINE M WILSON, DIANE J. GAERTNER, JAMES O. MARX, AND  
F. CLAIRE HANKENSON

Rabbits ( <i>Oryctolagus cuniculus</i> )	1232
Guinea pigs ( <i>Cavia porcellus</i> )	1233