

Contents

Contributors, ix

Manuscript reviewers, xi

Preface, xiii

1 Decoding and Encoding the "DNA" of Teaching and Learning in College Classrooms, 1

Michel A. Wattiaux

Introduction, 1

Teaching and learning: definitions, 1

Understanding learning, 2

Understanding teaching, 5

Implications for classroom design in the twenty-first century, 6

Final thoughts, 9

References, 10

Review questions, 11

Section 1: Quantitative and Population Genetics, 13

2 Mating Systems: Inbreeding and Inbreeding Depression, 15

David L. Thomas

Introduction, 15

Inbreeding, 15

Cause of inbreeding depression, 18

Quantifying inbreeding, 20

Genomics and inbreeding, 23

Summary, 23

Further reading, 24

References, 24

Review questions, 24

3 Genomic Selection, Inbreeding, and Crossbreeding in Dairy Cattle, 25

Kent Weigel

Introduction, 25

Genomic selection, 25

Crossbreeding, 28

Inbreeding and genetic defects, 29

Summary, 30

References, 30

Review questions, 31

4 Basic Genetic Model for Quantitative Traits, 33

Guilherme J. M. Rosa

Introduction, 33

Quantitative traits, 33

Expected value and variance: the normal distribution, 33

Basic genetic model for quantitative traits, 35

Heritability and selection, 35

Predicting rate of genetic change from selection, 36

Further reading, 37

References, 37

5 Heritability and Repeatability, 39

Guilherme J. M. Rosa

Introduction, 39

Heritability, 39

Estimation of heritability and variance components, 40

Prediction of breeding values and of response to selection, 41

Repeatability, 41

References, 42

6 Applications of Statistics in Quantitative Traits, 43

Hayrettin Okut

Population and sample, 43

Descriptive statistics, 43

Graphically examining the distribution of the data, 47

Normal distribution, 49

Exploring relationships between variables, 53

Summary, 59

Appendix 6.1, 62

Further reading, 62

References, 62

Review questions, 63

Section 2: Applications of Genetics and Genomics to Livestock and Companion Animal Species, 65

7 Genetic Improvement of Beef Cattle, 67

Michael D. MacNeil

Introduction, 67

Single trait selection, 67

National cattle evaluation, 69
Multiple trait selection, 71
Summary, 71
Further reading, 71
References, 72

8 Genetic Improvement in Sheep through Selection, 73

David L. Thomas

Products from sheep, 73
Selection among breeds, 73
Selection within a breed or population and the Key Equation, 73
Adjustment for environmental effects, 73
Phenotypic selection, 75
Estimated breeding values (EBV), 75
Using multiple sources of information, 76
Genetic correlations, 76
Selection intensity, 78
Generation interval (L), 79
Predicting progress from selection, 79
National genetic improvement programs, 80
Summary, 81
Further reading, 82
References, 82
Review questions, 82

9 Genetic Improvement Programs for Dairy Cattle, 85

Kent Weigel

Introduction, 85
Data collection infrastructure, 85
Estimation of breeding values, 87
Selection for increased productivity, 89
Selection for functional traits, 91
Sire selection, 94
Summary, 94
Further reading, 95
References, 95
Review questions, 96

10 Genetic and Genomic Improvement of Pigs, 97

Max F. Rothschild

Introduction, 97
Domestication of swine and breed development, 97
Methods of selection and mating systems, 98
Traits of economic importance, 99
Development of molecular genetic approaches, 100
QTL, candidate genes, and genetic improvement, 100
Sequencing the pig genome, 101
Genomic selection, 102
Databases, 103
Cloning, transgenics, and breeding pigs as biological models, 103
Future applications to genetic improvement, 103
Acknowledgments, 104
Further reading, 104
References, 104
Review questions, 105

11 Equine Genetics, 107

Jennifer Minick Bormann

Color, 107
Genetic defects, 110
Inbreeding and relationship, 113
Selection and improvement, 114
New technologies, 116
Further reading, 117
References, 119
Review questions, 119

12 Genetics and Genomics of the Domestic Dog, 121

Leigh Anne Clark and Alison Starr-Moss

Introduction to canine research, 121
The dog genome, 122
Uncovering the genetic basis of phenotypes, 125
Future challenges, 127
Summary, 128
Further reading, 129
References, 130
Review questions, 130

13 The Sheep Genome, 131

Noelle E. Cockett and Chunhua Wu

Investment in sheep genome research, 131
Overview of the sheep genome, 131
Genomic resources in sheep, 131
Application of genomic resources, 134
Summary, 134
References, 135
Review questions, 136

14 Goat Genetics and Genomic Progress, 137

Mulumebet Worku

Introduction, 137
Genetics and goat domestication, 137
Taxonomy, 138
Goat chromosome number and structure, 138
Patterns of inheritance, 139
Quantitative trait loci (QTL), 139
Progress in goat genomics, 139
Biotechnologies and goat genetics, 140
Summary, 140
Further reading, 140
Review questions, 141

Section 3: Molecular Genetics of Production and Economically Important Traits, 143

15 Bioinformatics in Animal Genetics, 145

José A. Carrillo and Jiuzhou Song

Introduction, 145
Bioinformatics and animal genetics, 145
The importance of bioinformatics in genomics research, 146
Gene expression, 148
Gene regulation, 150

Epigenetics, 151
 Genomic data manipulation, 151
 Bioinformatics perspectives in animal genetics, 153
 References, 153
 Review questions, 154

16 Genome-wide Association Studies in Pedigreed Populations, 155

Dirk-Jan de Koning

Introduction, 155
 Methods and tools for GWAS in
 pedigreed populations, 159
 Things to remember about analysis, 160
 What did we miss?, 160
 Acknowledgments, 162
 References, 162

17 Molecular Genetics Techniques and High Throughput Technologies, 163

Wen Huang

Central dogma of molecular biology, 163
 Review of properties of nucleic acids, 163
 Purification of nucleic acids from cells, 164
 Determining the quantity and purity of
 nucleic acids, 165
 Polymerase chain reaction (PCR), 166
 Determining the identity of DNA, 167
 Concept of parallelization and high
 throughput assays, 168
 Next generation sequencing technology, 171
 Summary, 174
 Further reading, 174
 Review questions, 174

18 Single Genes in Animal Breeding, 177

Brian W. Kirkpatrick

Introduction, 177
 Mapping and identifying single genes, 177
 What types of DNA sequence alterations create single gene
 effects?, 180
 Examples of single genes in animal breeding, 181
 Summary, 185
 References, 185
 Review questions, 186

19 Molecular Genetics of Coat Color: It is more than Just Skin Deep, 187

Samantha Brooks

Introduction, 187
 Pathways of melanocyte migration and differentiation from
 the neural crest, 187
 Melanocyte signaling and regulation, 188
 Melanin production and transport, 190
 Conclusions, 192
 Summary, 192
 Key terms, 192
 References, 193
 Review questions, 195

20 Molecular Genetics-Nutrition Interactions in Ruminant Fatty Acid Metabolism and Meat Quality, 197

Aduli E.O. Malau-Aduli and Benjamin W.B. Holman

Introduction, 197
 Genetics-nutrition interactions in ruminants, 197
 Educating Australian undergraduate students in molecular
 genetics-nutrition interactions in ruminants, 198
 Review of fatty acids and their manipulation, metabolism,
 and effect on quality in ruminants, 200
 Concluding remarks, 205
 Appendix 20.1: Fats and beef quality laboratory practicals,
 206
 Appendix 20.2: Sensory evaluation of meat quality in
 grain-fed versus grass-fed beef, 206
 Appendix 20.3: Total lipid extraction from a beef cut for
 fatty acid analysis, 206
 Appendix 20.4: Molecular genetics laboratory practical, 207
 References, 212

21 Nutritional Epigenomics, 215

Congjun Li

Introduction, 215
 Epigenomic machinery and gene regulation, 216
 Nutrients and histone modification, 219
 Nutrients and epigenetics in bovine cells: one definitive
 example of the nutrient-epigenetic-phenotype
 relationship, 221
 Summary, 224
 References, 224
 Review questions, 225

Section 4: Genetics of Embryo Development and Fertility, 227

22 Genomics of Sex Determination and Dosage Compensation, 229

Jenifer Cruickshank and Christopher H. Chandler

Genotypic sex determination (GSD), 229
 Environmental sex determination (ESD), 232
 Dosage compensation in mammals: X chromosome
 inactivation, 232
 Activity patterns of sex chromosomes during
 gametogenesis, 233
 Escape from X inactivation, 234
 Abnormalities in chromosomal sex, 235
 Sex reversal, 235
 Summary, 236
 Further reading, 236
 Review questions, 237

23 Functional Genomics of Mammalian Gametes and Preimplantation Embryos, 239

*Şule Doğan, Aruna Govindaraju, Elizabeth A. Crate,
 and Erdoğan Memili*

Introduction, 239
 Gamete and embryo development, 239

Transcriptomics, 242
 Proteomics, 248
 Systems biology, 251
 Conclusion, 253
 Further reading, 253
 References, 253

24 The Genetics of *In Vitro* Produced Embryos, 257

Ashley Driver

In vitro production: from livestock to humans, 257
 Unlocking developmentally important genes in the pre-implantation embryo, 258
 IVP: potential source of genetic alteration?, 259
 PGD: genetic screening and human embryos, 259
 Screening the embryo: to infinity and beyond?, 260
 Embryogenetics: what's next?, 260
 Summary, 260
 Key terms, 260
 References, 261
 Review questions, 262
 Supplementary videos, 262

Section 5: Genetics of Animal Health and Biotechnology, 263

25 Understanding the Major Histocompatibility Complex and Immunoglobulin Genes, 265

Michael G. Gonda

Introduction, 265
 Overview of the immune system, 265
 The major histocompatibility complex loci, 267
 Immunoglobulin loci, 268
 Summary, 272
 Key terms, 273
 Further reading and references, 274
 Review questions, 274

26 Livestock and Companion Animal Genetics: Genetics of Infectious Disease Susceptibility, 275

Michael G. Gonda

Introduction, 275
 Why is studying the genetics of disease susceptibility important?, 275
 Present applications of genetic selection tools for predicting disease susceptibility, 276
 Current research into genetic selection for livestock health, 279
 Challenges faced when studying the genetics of disease resistance in livestock, 280
 Should we select for increased disease resistance?, 281
 Summary, 281
 Key terms, 281

Further reading, 282
 Review questions, 282

27 Animal Genetics and Welfare, 283

Amin A. Fadl and Mark E. Cook

Introduction, 283
 A continued need for genetic improvements and knowledge, 283
 Welfare, 284
 Genetic advancement and animal welfare, 284
 Genetic selection that adversely affects farmed animal welfare, 286
 Summary, 287
 References, 287
 Review questions, 288

28 Animal Biotechnology: Scientific, Regulatory and Public Acceptance Issues Associated with Cloned and Genetically Engineered Animals, 289

Alison L. Van Eenennaam

What is animal biotechnology?, 289
 Cloning, 290
 Genetic engineering, 293
 Ethical, moral, and animal welfare concerns, 297
 Summary, 299
 Further reading, 300
 References, 300
 Review questions, 301

29 Intellectual Property Rights and Animal Genetic Resources, 303

Jennifer Long and Max F. Rothschild

Introduction, 303
 Old M/cDonald's Farm meets Dolly (and her lawyer), 303
 What is intellectual property?, 303
 Forms of intellectual property, 303
 Here a patent, there (not) a patent, 304
 Forms of payment or remuneration, 305
 Case studies, 306
 E-I-E-I-O: The alphabet soup of domestic and international issues, 307
 Public sector research and IP – domestic and international, 307
 Access to animal genetic resources, 307
 Summary, 308
 Further reading, 308
 References, 308
 Review questions, 309

Index, 311