
Contents

Contributors	xi
Preface	xv
1 Number and Size of Muscle Fibres in Relation to Meat Production	1
C. Rehfeldt, I. Fiedler and N.C. Stickland	
1.1 Introduction	2
1.2 Principles of Skeletal Muscle Growth	2
1.3 Factors Influencing Muscle Fibre Number and Size	7
1.4 Significance of Muscle Fibre Number and Size for Animal Performance	20
1.5 Conclusions	29
References	30
2 Fibre Type Identification and Functional Characterization in Adult Livestock Animals	39
C. Reggiani and F. Mascarello	
2.1 Introduction: Definition of 'Fibre Type'	39
2.2 Fibre Types and Myosin Isoforms	42
2.3 Methods for Fibre Type Identification in Various Mammalian Species	44
2.4 Coordinated Expression of the Myofibrillar Protein Isoforms Determines the Contractile Performance	50
2.5 Contraction Speed is Related to the Excitation–Contraction Coupling	53
2.6 Fatigue Resistance is Related to the Balance Between Energy Production and Energy Consumption	55
2.7 Muscle Fibre Type Composition in Adult Livestock Animals	56
2.8 Conclusions	61
Acknowledgements	62
References	62

3 Manipulation of Muscle Fibre Number During Prenatal Development	69
N.C. Stickland, S. Bayol, C. Ashton and C. Rehfeldt	
3.1 Introduction	69
3.2 Prenatal Muscle Development	70
3.3 Natural Variation in Development	71
3.4 Prenatal Nutrition	73
3.5 Growth Promoters	75
3.6 Temperature	76
3.7 Conclusion	78
References	79
4 The Effect of Growth and Exercise on Muscle Characteristics in Relation to Meat Quality	83
E.G. Dingboom and W.A. Weijs	
4.1 Introduction	83
4.2 Muscle Fibre Types	84
4.3 Capillarity	87
4.4 Relationship between Meat Quality and Muscle Properties	88
4.5 Postnatal Development	90
4.6 The Influence of Exercise	92
4.7 Conclusions	94
References	95
5 Nutrition, Hormone Receptor Expression and Gene Interactions: Implications for Development and Disease	103
M.J. Dauncey, M. Katsumata and P. White	
5.1 Introduction	104
5.2 Nutritional Regulation of Muscle Development	104
5.3 Hormones, Receptors and Muscle Development	105
5.4 Nutritional Regulation of Hormones, Receptors and Gene Expression	110
5.5 Implications for Health and Disease	116
Acknowledgement	118
References	119
6 The Impact of Minerals and Micronutrients on Growth Control	125
I. Dørup	
6.1 Introduction	125
6.2 The Effect of Specific Mineral and Micronutrient Deficiencies on Growth and Protein Synthesis	126
6.3 The IGF System and its Regulation	128
6.4 Effect of Specific Mineral and Micronutrient Deficiencies on the IGF System	129
6.5 Human Studies	131
6.6 Summary and Conclusions	133
References	133

7	Na⁺,K⁺-ATPase in Skeletal Muscle: Significance of Exercise and Thyroid Hormones for Development and Performance	137
	S. Slob, P.H.M. Klaren and M.E. Everts	
7.1	Introduction	137
7.2	Na ⁺ ,K ⁺ -ATPase in Skeletal Muscle	138
7.3	Na ⁺ ,K ⁺ -ATPase in Livestock and Domestic Species	144
7.4	Na ⁺ ,K ⁺ -ATPase During Development	149
7.5	Conclusion	151
	References	152
8	Local and Systemic Regulation of Muscle Growth	157
	G. Goldspink	
8.1	Summary	157
8.2	Introduction	158
8.3	Systemic Control of Muscle Growth	164
8.4	Cloning of Local Insulin-like Growth Factors	165
8.5	Conclusions	167
	Acknowledgements	168
	References	168
9	Proteolytic Systems and the Regulation of Muscle Remodelling and Breakdown	173
	V.T. Los and H.P. Haagsman	
9.1	Introduction	174
9.2	Models and Methods used to Study Proteolysis	177
9.3	Regulation of Protease Expression	181
9.4	Regulation of Substrate Degradation	185
9.5	Conclusion	192
	References	194
10	The Muscle Regulatory Factors Gene Family in Relation to Meat Production	201
	P.H.J. Houba and M.F.W. te Pas	
10.1	Introduction	202
10.2	Regulation of the Development of Skeletal Muscle Fibres: Importance for Livestock Production	202
10.3	The Muscle Regulatory Factors Gene Family	204
10.4	MRF Genes and Regulation of Muscle Mass: Conclusions from the Knockout/Kick-in Mice	207
10.5	Relationships between Genomic Variation in the MRF Gene Loci and Skeletal Muscle Mass/Meat Mass Determination in Livestock Meat Production	207
10.6	Use of Genetic Variation in the Prenatal and Postnatal Expression Level of MRF Genes to Enhance Muscle Mass/Meat Production	210
10.7	Discussion: MRF Genomic Variation and Expression Affects Muscle Mass, and thus Livestock Meat Production	212
10.8	New Directions for the Research and Livestock Breeding for Meat Production	214

10.9	Towards Identification of Genes that are Regulated by the MRF Proteins in Muscle Tissue References	215 218
11	The Muscle Transcriptome K. Wimmers, S. Ponsuksili and K. Schellander	225
11.1	Motives to Address the Muscle Transcriptome	225
11.2	Complexity of the Genome, Transcriptome and Proteome: Strategic Implications	227
11.3	Identification of Skeletal Muscle Expressed Sequence Tags	229
11.4	Methods to Illuminate the Transcriptome and to Relate Muscle Differential Expression and Phenotype	232
11.5	Prospective of Functional Genomics in Livestock Species References	239 240
12	Genome Analysis of QTL for Muscle Tissue Development and Meat Quality M.F. Rothschild, J.P. Bidanel and D.C. Ciobanu	247
12.1	Introduction	247
12.2	Major Genes Identified in Populations	248
12.3	Genomic Scanning and Candidate Gene Approaches	249
12.4	QTL and Candidate Gene Results	250
12.5	Future Research Approaches	260
12.6	Practical Applications in the Pig Industry Acknowledgements References	261 262 262
13	Functional Genomics and Proteomics in Relation to Muscle Tissue C. Maltin and G. Plastow	267
13.1	Introduction	267
13.2	Muscle Development and Growth	268
13.3	Functional Genomics	272
13.4	Proteomics	279
13.5	The Application of Functional Genomics and Proteomics to Livestock Breeding	284
13.6	Conclusion Acknowledgements References	288 288 288
14	Role of Myostatin in Muscle Growth R. Kambadur, A. Bishop, M.S. Salerno, S. McCroskery and M. Sharma	297
14.1	Introduction	297
14.2	Double-muscling in Cattle	298
14.3	Myostatin – a Negative Regulator of Muscle Mass	299
14.4	Structure and Function of Myostatin	299
14.5	Receptor Binding and Downstream Signalling by Myostatin	303

14.6	Modifiers of Myostatin Function	304
14.7	<i>Myostatin</i> Expression	305
14.8	Transcriptional Regulation of <i>Myostatin</i> Gene Expression	306
14.9	Physiological Role of Myostatin	307
14.10	Mechanism of Myostatin Function	310
14.11	Perspectives and Conclusion	311
	Acknowledgements	311
	References	312
15	The <i>Callipyge</i> Mutation for Sheep Muscular Hypertrophy – Genetics, Physiology and Meat Quality	317
	B.A. Freking, T.P.L. Smith and K.A. Leymaster	
15.1	Introduction	317
15.2	<i>CLPG</i> Map Location and Muscle Hypertrophy Phenotype Gene Action	318
15.3	Gene Action Associated with Meat Quality Phenotypes	320
15.4	Fine Mapping and Positional Cloning of the <i>CLPG</i> Mutation	324
15.5	Preliminary Functional Evaluation of Mutated Region	326
15.6	Expression Profiles and Imprint Status of Genes Near the Mutation	327
15.7	Summary of <i>CLPG</i> Domain Expression	330
15.8	Impact of <i>CLPG</i> Mutation on Growth, Slaughter and Carcass Traits	330
15.9	Impact of <i>CLPG</i> Mutation on Meat Quality Traits	333
15.10	Conclusion	338
	Disclaimer	339
	References	339
16	Genetic Control of Intramuscular Fat Accretion	343
	F. Gerbens	
16.1	Introduction	343
16.2	Intramuscular Fat Physiology	344
16.3	Intramuscular Fat and Meat Quality	349
16.4	Strategies to Improve Intramuscular Fat Accretion	350
16.5	Marker-assisted Selection of Intramuscular Fat Content	351
16.6	Prospects for Breeding on Intramuscular Fat	355
	References	356
17	Post-mortem Muscle Proteolysis and Meat Tenderness	363
	D.L. Hopkins and R.G. Taylor	
17.1	General Introduction	363
17.2	Introduction to Mechanisms of Tenderization	364
17.3	Degradation of Myofibrillar Proteins	365
17.4	Cathepsins	369
17.5	Calpains	370
17.6	Inhibition of Cathepsins and Calpains	378
17.7	Serine Proteases and Proteasomes	380
17.8	Conclusions	381

Acknowledgements	381
References	381
18 Water-holding Capacity of Meat	389
K.O. Honikel	
18.1 Introduction	389
18.2 Methods for the Measurement of Water-holding Capacity	390
18.3 Muscle Structure and Water Distribution	391
18.4 Changes Post Mortem and Water-holding Capacity	392
18.5 First Conclusion	394
18.6 Processing of Meat and Water-holding Capacity	395
18.7 Conclusion on the Effects of Processing on Water-holding Capacity	398
References	399
Perspectives	401
Index	403