

Contents

Preface *xxiii*

Acknowledgments *xxv*

About the Companion Website *xxvii*

Section I The Basics of Nutrition *1*

1 Nutrients and Energy *3*

Introduction *3*

Nutrients *3*

Measures of Energy *4*

Gross Energy *4*

Digestible Energy *4*

Feeding Trials *4*

Calculation Method *5*

Energy Density *5*

References *8*

2 Water *11*

Introduction *11*

Water Quality *11*

Water Loss *12*

Water Gains *12*

Voluntary Oral Intake *12*

References *13*

3 Carbohydrates *15*

Introduction *15*

Monosaccharides *15*

Disaccharides *16*

Oligosaccharides *16*

Polysaccharides *16*

Carbohydrate Types *17*

Resistant Starches *18*

Carbohydrate Digestion *18*

Carbohydrate Functions *18*

Cats and Carbohydrates *19*

References *19*

4 Fats 21

- Introduction 21
- Triglycerides 21
- Lipoproteins 22
- Cholesterol 22
- Nutrient Density 22
- Fat Digestion 23
- Essential Fatty Acids 23
- Short-Chain Fatty Acids 24
- Lipid Functions 25
- Lipid Deficiencies 25
- References 25

5 Protein and Amino Acids 27

- Introduction 27
- Functions of Proteins 28
- Glucogenic and Ketogenic Amino Acids 29
- Dietary Protein 29
- Protein Quality 30
- Taurine 31
- References 31

6 Vitamins 33

- Introduction 33
- Fat-Soluble Vitamins 34
 - Vitamin A 34
 - Vitamin D 36
 - Vitamin E 37
 - Vitamin K 38
- Water-Soluble Vitamins 39
 - B-Complex Vitamins 39
 - Thiamin 39
 - Riboflavin 39
 - Niacin 40
 - Pyridoxine 40
 - Pantothenic Acid 41
 - Folic Acid 41
 - Biotin 42
 - Cobalamin 42
 - Choline 43
 - Vitamin C 43
- Vitamin-Like Substances 43
 - Carnitine 43
 - Carotenoids 44
 - Bioflavonoids 44
- References 44

7 Minerals 47

- Introduction 47

Macrominerals	48
Calcium	48
Phosphorus	50
Magnesium	50
Sodium and Chloride	50
Sulfur	51
Microminerals	51
Iron	51
Zinc	52
Copper	52
Selenium	53
Iodine	53
Chromium	53
References	54

8 Digestion and Absorption 55

Introduction	55
Digestive Tract	55
Mouth	55
Stomach	56
Small Intestine	57
Bile Salts	58
Hormones in Digestion	58
Digestion After the Intestines	58
Large Intestine	59
References	60

9 Energy Balance 61

Introduction	61
Units of Measure	61
Daily Energy Requirements	61
Resting Energy Requirements	62
Common Measurements of Energy	62
Basal Energy Requirement (BER)	62
Resting Energy Requirement (RER)	62
Maintenance Energy Requirement (MER)	62
Daily Energy Requirement (DER)	62
Gross Energy (GE)	62
Digestible Energy (DE)	62
Metabolizable Energy (ME)	62
Kilocalorie (kcal)	63
3500 kcal	63
Energy Expenditure	63
Body Heat Production	63
Facultative Thermogenesis	63
Voluntary Oral Intake	64
Nutrient Composition	65
Estimated Energy Requirements	65
References	66

10 Gastrointestinal Microbiome 69

- Introduction 69
- Microbiome 69
- Commensal Microbiota 69
- Benefits to the Host 70
- The Immune System 70
- Bacteria 71
- Other Components of the Microbiota 72
- Effects of Diet on the Microbiota 72
- Dysbiosis 73
- Conclusion 75
- References 75

11 Prebiotics, Probiotics and Synbiotics 77

- Introduction 77
- Definitions 77
- The Intestines 78
- Prebiotics 78
- Probiotics 79
- Synbiotics 80
- Survivability and Label Claims 80
- Conclusion 81
- References 81

12 Nutrition Calculations 83

- Introduction 83
- Units of Measure 83
- Converting Units 84
- Calculating Resting Energy Requirements (RER) 84
- Calculating Daily Energy Requirements (DER) 85
- Calculating Feeding Amounts 85
- Tube Feeding Calculations 86
- Converting Guaranteed Analysis to Energy Density 86
 - Energy Density Equals 87
- Calculating Nutrients as a Percent Metabolizable Energy (ME) Total Calories in 100 g of Food 87
- Calculating Meals per Can/Cup/Bag 87
- Cost of Feeding 88
- Conclusion 88
- References 88

Section II Nutritional Requirements of Dogs and Cats 89**13 History and Regulation of Pet Foods 91**

- Introduction 91
- Marketing of Pet Foods 91

Production of Pet Foods	92
Regulatory Agencies	92
Association of American Feed Control Officials	92
FDA	93
USDA	94
NRC	94
PFI	94
States	94
Food Recalls	95
Regulations	95
Conclusion	96
References	96

14 Pet Food Labels 97

Introduction	97
Definition of Terms	97
Complete	97
Balanced	97
Regulations	97
Principal Display Panel	98
Product Naming	99
Nutritional Adequacy	99
Information Panel	100
Complete and Balanced for All Life Stages	103
Limited Claim	103
Intermittent or Supplemental	103
Therapeutic	103
Other Label Claims	104
References	104

15 Nutrient Content of Pet Foods 105

Introduction	105
Laboratory Analysis	105
Calculation	105
Final Product Analysis	106
Digestibility	106
Feeding Trials	107
Food Comparisons	107
Metabolizable Energy	108
References	111

16 Types of Pet Foods 113

Introduction	113
Pet Food Library	113
Commercial Diets	113
Dry Pet Foods	114
Moist Pet Foods	115

Semi-Moist Foods	116
Raw	117
Snacks and Treats	118
Toxicity and Recalls	119
References	119

17 Raw Food Diets 121

Introduction	121
Government and Professional Associations	121
Nutritional Content	122
Bacterial Contamination in Food	123
Health of the Pets	124
Dental Health	124
Digestion and Digestive Enzymes	124
Options	125
Conclusion	125
References	125

18 Grain-Free and Boutique Diets 127

Introduction	127
Marketing Versus Science	127
Grains	127
Carbohydrate Digestion	128
Grain Substitutes	128
Nutrient Profiles	128
Dilated Cardiomyopathy	128
Boutique Foods	130
References	130

19 Additives and Pet Food Preservatives 133

Introduction	133
Antioxidants	133
Naturally Derived Antioxidants	134
Synthetic Antioxidants	135
Antimicrobials	136
Functional Ingredients	136
Colors	137
Artificial Flavors and Flavor Enhancers	137
Texture and Mouth Feel	137
Smell	137
Need for Additives	137
References	138

20 Homemade Diets 141

Introduction	141
Why Home Made?	142
Food Preparation	142
Ingredient Choices	143
Assess the Recipe	143

Selecting a Diet	144
Additional Instructions	145
Patient Assessment and Monitoring	145
References	146

21 Resources for Alternative Diets 147

Introduction	147
Descriptors	147
Natural	147
Free in Foods	147
Organic	148
Raw Foods	148
Client Communications	148
Guidelines	148
Options	149
References	149

Section III Feeding Management for Dogs and Cats 151

22 Feeding Regimens for Dogs and Cats 153

Introduction	153
Dogs	153
Cats	154
What to Feed	155
Feeding Regimens	156
Free-Choice Feeding	156
Time-Controlled Feeding	157
Portion-Controlled Feedings	157
Puzzle Feeders	159
Behavioral Problems	159
Introducing Puzzles	160
References	160

23 Nutritional Assessment 163

Introduction	163
Screening Evaluation	163
Extended Evaluation	163
Body Condition Scoring	164
Body Condition Score Uses	167
Muscle Condition Scoring	168
Communicating a Nutritional Recommendation	170
References	171

24 Pregnancy and Lactation in Dogs 173

Introduction	173
Pregnancy	173
Lactation	174
The Puppies	174
What to Feed	174

Nutrients	175
Water	175
Protein	175
Fats	176
Carbohydrates	176
Calcium and Phosphorus	176
Digestibility	177
References	177

25 Pregnancy and Lactation in Cats 179

Introduction	179
First Heat Cycle	179
Pregnancy	179
Lactation	180
The Kittens	180
What to Feed	180
Nutrients	181
Water	181
Protein	182
Fat	182
Digestible Carbohydrates	183
Calcium and Phosphorus	183
References	183

26 Neonatal Puppies and Kittens 185

Introduction	185
Nutrition	185
Water	185
Protein	185
Fat	186
Carbohydrate	186
Calcium and Phosphorous	186
Colostrum	186
Milk	186
Thermoregulation	187
Orphans	187
Milk Replacers	188
Weaning	188
References	189

27 Growth in Dogs 191

Introduction	191
Normal Growth	191
What to Feed	192
Energy	192
Protein	192
Fats and Fatty Acids	193

Calcium and Phosphorus	193
Feeding Regimens	193
Large and Giant Breed Puppies	195
Hip Dysplasia (CHD)	195
Osteochondrosis (OCD)	196
What to Feed Large and Giant Breed Puppies	196
References	197

28 Growth in Cats 199

Introduction	199
Normal Growth	199
What to Feed	199
Energy	199
Protein	200
Fat and Fatty Acids	200
Calcium and Phosphorus	200
Potassium	201
Urinary pH	201
Deficiencies	201
Carbohydrates	201
Feeding Regimens	201
Reassessment	203
References	204

29 Adult Maintenance in Dogs 205

Introduction	205
Maintenance	205
Gender and Neuter Status	206
Activity Level	206
Environment	206
Water	207
Energy	207
Fats and Fatty Acids	207
Fiber	208
Protein	208
Antioxidants	208
Stress	208
Obesity	208
Feeding Plan	209
References	211

30 Adult Maintenance in Cats 213

Introduction	213
Cats as Carnivores	213
Maintenance	213
Gender and Neuter Status	213
Environment and Activity Level	214

Water	214
Energy	214
Fats and Essential Fatty Acids	214
Fiber	215
Protein	215
Urinary pH	216
Antioxidants	216
Requirements	217
Canned Versus Dry Food	218
Obesity	219
References	220

31 Feeding the Healthy Geriatric Dog and Cat 221

Introduction	221
Feeding Requirements	222
Metabolism	222
Digestion	223
Protein	223
Fat	224
Fiber	224
Taste	225
Conclusion	225
References	226

32 Performance and Dogs 227

Introduction	227
Fats	228
Carbohydrate	229
Protein	230
Water	230
Supplements	231
Diet Requirements	231
Energy Considerations	232
Diet Calculations	232
Feeding Plan	232
References	234

33 Feeding Requirements of Cats 235

Introduction	235
Feeding Behaviors	235
Anatomic Adaptations	236
Physiologic Adaptations	236
Metabolic Adaptations	237
Energy	237
Water	237
Protein	238
Taurine	238

Methionine and Cystine	239
Arginine	239
Fats	239
Vitamin Metabolism	239
Conclusion	240
References	240

34 Nutrition Myths 241

Introduction	241
Myth: Meat By-Products are Inferior in Quality Compared to Whole Meat in a Diet	241
Myth: Feeding Trials are not Necessary	242
Myth: Pet Food Preservatives are Bad	243
Myth: All Foods are Created Equally	244
Myth: Corn is just Filler	245
Conclusion	246
References	246

35 Cost of Feeding 247

Introduction	247
Cost per Bag-Dry Food	247
Cost per Can	248
Conclusion	248

Section IV Nutritional Disease Management for Dogs and Cats 249

36 Nutritional Management of Gastrointestinal Disorders 251

Assessment	252
Nutritional Factors	255
Water	255
Electrolytes	256
Protein	256
Glutamine	256
Arginine	257
Fat	257
Carbohydrates	257
Fiber	257
Food Form and Temperature	258
Vitamins and Trace Minerals	258
GI Bacterial Ecosystem	258
Acid Load	258
Summary	258
Further Reading	259

37 Critical Care Nutrition 261

What Patients Should be Fed?	261
------------------------------	-----

How Should the Patient be Fed?	262
What Should the Patient be Fed?	263
Summary	266
Further Reading	266

38 Assisted Feeding in Dogs and Cats 269

Introduction	269
Feeding Tube Materials	269
Nasoesophageal/Nasogastric Tube	270
Esophagostomy Tube Placement	271
Gastrostomy Tube	272
Jejunostomy Tube	273
Beginning Enteral Feeding	274
Diet Choices	274
Mechanical Complications	275
Gastrointestinal Complications	276
Metabolic Complications	276
Infectious Complications	277
Hospital Management	278
Potential Post-discharge Complications	278
Summary	279
References	279

39 Liver Disease 281

Key Nutritional Factors in Hepatobiliary Diseases	282
Chronic Hepatitis and Cirrhosis	283
Canine Copper Associated Hepatotoxicosis	283
Cholangitis	284
Portosystemic Shunts	284
Neoplasia	284
Hepatic Lipidosis	285
How Much to Feed?	286
Protein	287
Sodium and Chloride	287
Potassium	287
References	288

40 Dermatology 289

Patient History	289
Physical Examination	290
Common Skin Disorders in Dogs and Cats	290
Allergic Dermatitis	291
Adverse Reactions to Food	292
Nutritional Management	293
Key Nutritional Factors	293
Nutritional Protocol	294
References	296

41	Fatty Acids in Disease Management	299
	Fatty Acids	299
	Fatty Acid Deficiencies and Cardiac Disease	300
	Arrhythmia	300
	Omega-3 Fatty Acids and the Overall Effect on the Cardiac Patient	301
	Omega-3 Fatty Acids and Osteoarthritis	302
	FLUTD	303
	Cancer	303
	References	304
42	Endocrinology	307
	Diabetes Mellitus	307
	Key Nutritional Factors	308
	Water	308
	Energy	308
	Fiber	309
	Fat	309
	Protein	310
	Hyperthyroidism	310
	Water	311
	Energy/Fat	311
	Protein	311
	Fiber	312
	References	313
43	Cancer Nutrition	315
	Nutritional Assessment	315
	Metabolic Alterations in Patients with Cancer	315
	Alterations in Carbohydrate Metabolism	316
	Alterations in Protein Metabolism	316
	Fat Metabolism Alterations	316
	Starvation versus Cachexia	316
	Prevalence and Diagnosis	317
	Pathophysiology	317
	Nutrients to Consider in Cancer Management	318
	Soluble Carbohydrates and Fiber	318
	Protein	318
	Fat and Omega-3 Fatty Acids	319
	Antioxidant	319
	Vitamins	319
	Trace Minerals	319
	Tea Polyphenols	319
	Vitamin A	320
	References	320
44	Refeeding Syndrome	323
	Electrolytes	324
	Potassium	324

Phosphorus	325
Magnesium	325
Managing Refeeding Syndrome	325
Summary	326
References	327

45 Cardiac Disease 329

Key Nutritional Factors	330
Sodium and Chloride	330
Taurine	331
L-Carnitine	331
Phosphorus	331
Potassium and Magnesium	332
Protein	332
Omega-3 Fatty Acids	332
Water	333
Nutrition-Related Dilated Cardiomyopathy	333
The Misperceptions	334
References	337
Further reading	338

46 Musculoskeletal 339

Obesity as a Risk Factor	339
Clinical Signs	340
Stages of Canine Osteoarthritis	341
Nutrigenomics and Osteoarthritis	341
Managing Mobility Nutritionally	343
Key Nutrients	343
Developmental Orthopedic Disease	344
Patient Assessment	344
Key Nutritional Factors	345
Energy	345
Protein	346
Fat	346
Calcium and Phosphorus	346
Digestibility	347
Carbohydrates	347
References	347

47 Weight Management 351

Causes of Obesity	351
Health Risks Associated with Obesity	352
The Largest Endocrine Organ	352
Evaluating Weight and Nutrition	352
Body Condition Scoring (BCS)	353
Body Fat Index Risk Chart Validation	355
Weight Management Program	355
Determining Ideal Weight Matters	356
Client/Behavioral Factors	356

	Calorie Restriction	356
	Exercise	356
	Weight Management Guidelines	357
	Summary	357
	References	358
48	Cachexia	361
	Sarcopenia	361
	Starvation versus Cachexia	361
	Pathophysiology	362
	Phases of Cachexia	362
	Therapeutic Strategies	362
	Managing Anorexia/Hyporexia	362
	Key Nutritional Factors in the Management of Cachexia	363
	Feeding Methods	363
	Summary	364
	References	365
49	Dental Health	367
	Periodontal Disease	367
	Risk Factors for Periodontal Disease	368
	Nutrition and Tooth Development	369
	Nutrition and Dental Health	369
	Key Nutritional Factors	369
	Food Texture	370
	Protein	370
	Carbohydrates	370
	Fiber	370
	Antioxidants	371
	Minerals	371
	Vitamins	372
	Dental Home Care	372
	Dental Home Care Product Categories	373
	Pet Owner Education and Compliance	375
	References	377
50	Nutritional Management of Pancreatitis	379
	The Function of the Pancreas	379
	Pancreatitis	380
	History and Physical Examination	380
	Nutritional Evaluation	381
	Key Nutritional Factors	382
	Additional Nutritional Factors in Pancreatitis	383
	References	384
51	Nutrition in Pancreatic Insufficiency	385
	Pancreatic Acinar Atrophy	385
	Exocrine Pancreatic Insufficiency	386
	Clinical Signs	386

Laboratory Information	386
Nutritional Management	387
Key Nutritional Factors	387
Digestibility	387
Fat	387
Fiber	388
Vitamins	388
References	389

52 Nutritional Management of Hyperlipidemia in Dogs and Cats 391

Hyperlipidemia Classification	391
Clinical Signs	392
Dogs with Hyperlipidemia	392
Cats with Hyperlipidemia	392
Management	393
Nutritional History	393
Key Nutritional Factors	393
Fat	393
Fatty Acids	394
Vitamins	394
Fiber	394
Treats	394
References	395

53 Brain Aging/Cognitive Dysfunction 397

Aging and Its Effect on the Brain	398
Nutritional Management of Cognitive Dysfunction Syndrome	398
Cognitive Dysfunction Syndrome Summary	399
Brain Aging	399
Senior or Mature Adult Dogs	400
Senior or Mature Adult Cats	401
Completing a Nutritional Evaluation for Senior Pets	401
Scientific Tools	402
References	402

54 Kidney Disease 405

Prevalence	405
Clinical Signs	405
Staging of Chronic Kidney Disease	406
A New Kidney Biomarker	406
Nutritional Management of CKD	406
Water	407
Energy	407
Protein	407
Phosphorus	407
Alkalinizers and Buffers	408
Sodium and Chloride	408
Potassium	408
Omega-3 Fatty Acids	408

Antioxidants	408
B Vitamins	408
Soluble Fiber	409
Transition	409
Palatability	409
Texture	409
Taste Aversion	410
Follow Up	410
Features of Therapeutic Renal Foods	410
Summary	410
References	411

55 Nutritional Management of Digestive Disease in Brachycephalic Dogs 413

Brachycephalic Anatomy	413
Alimentary Tract Signs	414
Digestive Disease	414
History and Physical Examination	414
Medical Management	415
Nutritional Management	415
Body Condition Score	415
Key Nutritional Factors	415
Water	416
Protein	416
Fat	416
Fiber	416
Food Form and Temperature	416
Brachycephalic Bowls	416
Other Digestive Disease Nutrition Suggestions	417
Summary	417
References	417

56 Feline Lower Urinary Tract Disease 419

Causes of FLUTD	419
Diagnostic Evaluation	419
Pathogenesis of FIC	421
Nutritionally Managing Cats with FIC	421
Managing Cats with Feline Idiopathic Cystitis	422
Environmental Enrichment	423
Managing Cats with Struvite Uroliths or Urethral Plugs	423
Managing Cats with Calcium Oxalate Uroliths	424
Summary	424
References	424
Further Reading	425

Section V Feeding Management for other Companion Animals 427

57 Avian 429

Nutritional Overview	429
----------------------	-----

Nutritional Assessment	430
Commercially Prepared Diets	430
Avian Key Nutritional Factors	434
Water	434
Protein and Amino Acids	435
Fats and Essential Fatty Acids	435
Carbohydrates	435
Calcium	436
Vitamins and Minerals	436
Fruits and Vegetables	436
Poultry Nutrition for Backyard Flocks	437
Water	437
Energy	437
Carbohydrates	437
Fats	438
Proteins	438
Minerals	439
Vitamins	439
References	439

58 Small Pet Mammals and Reptiles 441

Nutritional Assessment	441
Ferrets	441
Rabbits	443
Guinea Pigs	444
Other Small Mammals	446
Reptiles	448
References	449

59 Equine 451

Nutritional Physiology	451
Key Nutritional Factors for Horses	452
Types of Feed	454
Pediatric Equine Nutrition and Care	455
Energy Requirement	456
Critical Care Nutrition	458
Enteral Nutrition	458
Parenteral Nutrition	459
References	461

Index 463