

Contents

Acknowledgements	xi
Foreword	xiii
Chapter 1. Introduction	1
METABOLIC BONE DISEASE: A DEFINITION	2
FORMAT OF THE BOOK	3
Chapter 2. The Study of Metabolic Bone Disease in Bioarchaeology	7
APPROACHES TO THE STUDY OF METABOLIC BONE DISEASE	7
CHALLENGES IN THE INVESTIGATION OF METABOLIC BONE DISEASE	10
Museum Collections	10
Archaeological Human Bone	11
Paleopathological Diagnoses	17
Demographic Issues	18
MODERN MEDICAL DATA	18
GENETICS AND ANTHROPOLOGY	19
CULTURAL AND SOCIAL ANTHROPOLOGY	19
NUTRITIONAL AND MEDICAL ANTHROPOLOGY	20
PRIMATOLOGY	20
CONCLUSIONS	20
Chapter 3. Background to Bone Biology and Mineral Metabolism	21
BONE TISSUE: CORTICAL AND TRABECULAR BONE	21
DIFFERENT TYPES OF BONE STRUCTURE: WOVEN BONE AND LAMELLAR BONE	22
BONE CELLS	24
MODELLING AND REMODELLING: GROWTH AND ADULTHOOD	28
Mechanisms of Growth	28
Modelling	28
Remodelling	29
Bone Mineralisation: The Extracellular Matrix (osteoid)	30
Tooth Formation and Mineralisation	32

REASONS FOR REMODELLING	32
<i>Box Feature 3.1. Bone Biology in Context of the Life Course</i>	33
BONE BIOLOGY IN FRACTURE HEALING	34
MINERAL METABOLISM DURING LIFE	36
Extracellular Mineral Metabolism	36
CONCLUSIONS	40
Chapter 4. Vitamin C Deficiency Scurvy	41
CAUSES OF VITAMIN C DEFICIENCY	41
Sources of Vitamin C	41
<i>Box Feature 4.1. Scurvy and Weaning</i>	45
THE ROLE OF VITAMIN C	47
Vitamin C Requirements	47
CONSEQUENCES OF SCURVY	48
Consequences for Adults	48
Consequences for Children	49
SCURVY IN THE MODERN PERSPECTIVE	49
ANTHROPOLOGICAL PERSPECTIVES	51
Reference to Probable Scurvy in Early Texts	51
<i>Box Feature 4.2. Subsistence Change and the Development of Scurvy: The Origins of Agriculture</i>	52
A More Recent View of Scurvy in the Past	54
PALEOPATHOLOGICAL CASES OF SCURVY	54
DIAGNOSIS OF SCURVY IN ARCHAEOLOGICAL BONE	56
Macroscopic Features of Infantile Scurvy	56
Macroscopic Features of Adult Scurvy	61
Radiological Features of Infantile Scurvy	62
Radiological Features of Adult Scurvy	63
Histological Features of Infantile Scurvy	65
Histological Features of Adult Scurvy	67
DIFFERENTIAL DIAGNOSIS	69
<i>Box Feature 4.3. Scurvy in Non-Human Primates: A Result of Human Actions</i>	71
CONCLUSIONS	71
APPENDIX: SUMMARY OF PUBLISHED ARCHAEOLOGICAL EVIDENCE FOR VITAMIN C DEFICIENCY	72
Chapter 5. Vitamin D Deficiency	75
THE SKELETAL REQUIREMENT OF VITAMIN D	75
TERMINOLOGY	77
CAUSES OF VITAMIN D DEFICIENCY	77
Sunlight	77
Cultural Practices and Sunlight Exposure	81
Skin Pigmentation and Genetic Adaptations	81
Food Sources	82

Pregnancy and Lactation	84
Increased Age	86
Age-Related Osteoporosis	87
Additional Causes of Vitamin D Deficiency with Effects on Mineral Metabolism	87
RICKETS	90
CONSEQUENCES OF RICKETS	91
Historical Recognition of Rickets	92
RICKETS IN THE MODERN PERSPECTIVE	92
ANTHROPOLOGICAL PERSPECTIVES: RICKETS	94
<i>Box Feature 5.1. Beyond Fighting: The Physiological Impact of Warfare</i>	96
PALEOPATHOLOGICAL CASES OF RICKETS	96
DIAGNOSIS OF RICKETS IN ARCHAEOLOGICAL BONE	97
Macroscopic Features of Rickets	97
Radiological Features of Rickets	100
Histological Features of Rickets	101
RESIDUAL RICKETS IN THE ANTHROPOLOGICAL PERSPECTIVE: ADULT EVIDENCE OF CHILDHOOD	
VITAMIN D DEFICIENCY	102
DIAGNOSIS OF RESIDUAL RICKETS IN ARCHAEOLOGICAL BONE	109
Macroscopic Features of Residual Rickets	109
Radiological Features of Residual Rickets	112
Histological Features of Rickets	112
CO-MORBIDITIES	113
DIFFERENTIAL DIAGNOSIS	114
VITAMIN D DEFICIENCY OSTEOMALACIA	114
Pseudofractures	118
ADULT VITAMIN D DEFICIENCY IN THE MODERN PERSPECTIVE	119
<i>Box Feature 5.2. Physical and Non-Violent Manifestations of Abuse</i>	122
ANTHROPOLOGICAL PERSPECTIVES: OSTEOMALACIA	123
Paleopathological Cases of Osteomalacia	123
DIAGNOSIS OF OSTEOMALACIA IN ARCHAEOLOGICAL BONE	125
Macroscopic Features of Osteomalacia	125
Radiological Features of Osteomalacia	125
Histological Features of Osteomalacia	126
CONCLUSIONS	133
APPENDIX: SUMMARY OF PUBLISHED ARCHAEOLOGICAL EVIDENCE FOR VITAMIN D DEFICIENCY	134
 Chapter 6. Age-Related Bone Loss and Osteoporosis	 151
DEFINITIONS OF OSTEOPOROSIS	151
CAUSES OF AGE-RELATED OSTEOPOROSIS	152
Menopause	152
Increased Age	153

Peak Bone Mass	155
Mechanical Loading	155
Extremes of Exercise	156
Continuing Sub-Periosteal Apposition	157
Genetics and Population Groups	157
Nutrition and Lifestyle	158
SKELETAL FEATURES OF AGE-RELATED OSTEOPOROSIS	158
CONSEQUENCES OF AGE-RELATED OSTEOPOROSIS:	
FRACTURES	158
Distal Radius Fractures (Colles' Fractures)	160
Vertebral Fractures	163
Femoral Fractures	167
OSTEOPOROSIS IN THE MODERN PERSPECTIVE	170
ANTHROPOLOGICAL PERSPECTIVES	171
<i>Box Feature 6.1. Historical and Anthropological Perspectives of Aging</i>	172
Age-Related Osteoporosis in Men	172
<i>Box Feature 6.2. Animal Studies in Osteoporosis I: Age-Related Bone Loss</i>	173
<i>Box Feature 6.3. Problems in the Determination of Age-Related Bone Changes in Biological Anthropology</i>	175
PALEOPATHOLOGICAL CASES OF AGE-RELATED OSTEOPOROSIS	176
CO-MORBIDITIES	179
DIAGNOSIS OF AGE-RELATED BONE LOSS AND OSTEOPOROSIS IN ARCHAEOLOGICAL BONE	179
Macroscopic Features of Osteoporosis	179
Radiological Features of Osteoporosis	179
Histological Changes of Osteoporosis	182
CONCLUSIONS	183
Chapter 7. Secondary Osteopenia and Osteoporosis	185
CAUSES OF SECONDARY OSTEOPENIA AND OSTEOPOROSIS	185
OSTEOPENIA AND MOBILITY	185
Effects of Immobilisation	186
<i>Box Feature 7.1. Animal Studies in Osteoporosis II: Immobilisation-Related Osteopenia</i>	187
Trauma and Causes of Immobility	188
Non-Long Bone Trauma and Additional Causes of Disuse Osteoporosis	188
Bone Loss in Infectious Diseases	192
Immobility in Viral Conditions	197
Congenital and Developmental Conditions	197
Osteopenia in Spinal Cord or Neuromuscular System Afflictions	197
<i>Box Feature 7.2. Implications of Immobility and Inferences of Disability</i>	198
OSTEOPENIA IN PATHOLOGICAL CONDITIONS	199
Joint Disease	199
Hematopoietic Conditions	200
Neoplastic and Malignant Conditions	200

THE INFLUENCE OF DIET ON OSTEOPOROSIS RISK	202
Dietary Acid Load and Proposed Mechanisms of Bone Loss	202
Calcium	202
Protein	205
Fatty Acids	207
Fruit and Vegetables	207
ANTHROPOLOGICAL PERSPECTIVES	209
Calcium in the Evolutionary Perspective	209
The Effect of Meat Eating on Calcium Adequacy	211
<i>Box Feature 7.3. The Health of Adaptive and Transitional Diets: Integrated Approaches?</i>	212
Calcium Availability with the Onset of Domestication	213
DIAGNOSIS OF SECONDARY OSTEOPENIA IN	
ARCHAEOLOGICAL BONE	216
CONCLUSIONS	216
Chapter 8. Paget's Disease of Bone	217
POSSIBLE CAUSES OF PAGET'S DISEASE	217
<i>Box Feature 8.1. Animal Paleopathology</i>	219
CONSEQUENCES OF PAGET'S DISEASE	219
Pelvic Changes	221
Cranial Changes	221
Long Bone Changes	222
Other Bones that can be Affected	223
CO-MORBIDITIES	224
PAGET'S DISEASE IN THE MODERN PERSPECTIVE	225
Age and Sex	225
Geographic Variation	226
ANTHROPOLOGICAL PERSPECTIVES	226
PALEOPATHOLOGICAL CASES OF PAGET'S DISEASE	226
DIAGNOSIS OF PAGET'S DISEASE IN ARCHAEOLOGICAL	
BONE	230
Macroscopic Features of Paget's Disease	230
Radiological Features of Paget's Disease	231
Histological Features of Paget's Disease	237
DIFFERENTIAL DIAGNOSIS	238
<i>Box Feature 8.2. The Contribution of Paleopathology to Modern Medicine</i>	238
CONCLUSIONS	239
Chapter 9. Miscellaneous Conditions	241
FLUOROSIS	241
CONSEQUENCES OF FLUOROSIS	241
Dental Fluorosis	241
Skeletal Fluorosis	242
CO-MORBIDITIES	243

FLUOROSIS IN THE MODERN PERSPECTIVE	243
ANTHROPOLOGICAL PERSPECTIVES: FLUOROSIS	245
PALEOPATHOLOGICAL CASES OF FLUOROSIS	247
Other Conditions Linked to Intoxication	249
HYPERPARATHYROIDISM	250
CAUSES OF HYPERPARATHYROIDISM	250
Primary Hyperparathyroidism	250
Secondary Hyperparathyroidism	250
CONSEQUENCES OF HYPERPARATHYROIDISM	251
ANTHROPOLOGICAL PERSPECTIVES:	
HYPERPARATHYROIDISM	251
PALEOPATHOLOGICAL CASES OF HYPERPARATHYROIDISM	252
DIAGNOSIS OF HYPERPARATHYROIDISM IN	
ARCHAEOLOGICAL BONE	252
PELLAGRA	252
<i>Box Feature 9.1. Anthropological Investigations of Displaced Peoples</i>	256
STARVATION	257
<i>Box Feature 9.2. Malnutrition, Starvation and Osteoporosis</i>	258
RARE METABOLIC BONE DISEASES	258
Hyperostosis	258
Hypophosphatasia	259
Osteogenesis Imperfecta	260
Osteopetrosis	260
CONCLUSIONS	260
Chapter 10. Overview and Directions for Future Research	261
BONE BIOLOGY	261
VITAMIN C DEFICIENCY, SCURVY	262
VITAMIN D DEFICIENCY, RICKETS AND OSTEOMALACIA	262
AGE-RELATED OSTEOPOROSIS	263
SECONDARY OSTEOPENIA AND OSTEOPOROSIS	264
PAGET'S DISEASE OF BONE	265
MISCELLANEOUS METABOLIC BONE DISEASES	265
CONCLUSIONS	265
Bibliography	267
Index	321