Contents

1. Biology of Bone and Cartilage 1
Classification of Bone 1
Functions of Bone 2
Gross Structure of Long Bone 2
Types of Bone Tissue 2
Molecular Structure of Bone 4
Skeletogenesis/Bone Formation 10
Mechanism of Bone Growth 15
Cartilage 17

2. Physiology of Bone 25
Bone Turnover 25
Modeling and Remodeling 25
Basic Multicellular Unit (BMU) 26
Mechanical Influence on Bone 26
Bone Regulators 27
Purpose of Bone Remodeling 28
Goals of Remodeling 29
Remodeling Process 29

3. Prenatal Craniofacial Growth 33
Period of Ovum 33
Period of Embryo 34
Fetal Period 44
Development of Temporomandibular Joint (TMJ) 44
Changing Relationships in Fetal Face 44

4. Principles of Growth 46
Growth Pattern 47
Mechanism of Bone Growth 50
Growth Movements 52
Growth Equivalents Concept/Enlow Counterpart Principle 55

5. Control Mechanisms in Craniofacial Growth 57
Changing Paradigms of Craniofacial Biology 57
Site vs Center 60
Controlling Factors in Craniofacial Growth ... 60
Theories of Bone Growth 63

6. Postnatal Growth of the Craniofacial Skeleton 86
Postnatal Growth of Cranial Vault/Calvaria ... 86
Cranial Base 89
Nasomaxillary Complex 92
Mandible 97
Temporomandibular Joint 104
Dynamics of Facial Growth 105

7. Development of Human Dentition, Supporting Structures and Occlusion 109
Prenatal Development of Maxilla and Mandible 109
Chronology of Human Dentition 116
Eruption of Tooth 117
Evolution of Teeth 123
Development of Occlusion 126

8. Growth of Soft Tissues 137
Significance of Studying Soft Tissue Growth 137
Methods of Studying Soft Tissue Growth and Assessment of Balanced Profile 138
Soft Tissue Changes Due to Growth 139
Soft Tissue Changes with Treatment Procedures 144

9. Adolescence and Craniofacial Growth 147
Endocrinology of Adolescence 147
Timing of Puberty 150
Pubertal Growth Spurt 150
Clinical Features or Physical Changes of Pubertal Development 150
Facial Growth During Puberty 151

10. Growth Studies and Assessment of Age 155
Methods of Growth Measurements 155
Craniometry 156
Vital Staining 156
Histological Method 157
Histochemical Studies 157
Indirect Measurements 158
Serial Cephalometric Radiography and Implantation 159
Assessment of Age 159
Skeletal Age Assessment 162

11. Craniometry, Anthropometry and Cephalometrics in Growth 175
Anthropometry 175
Craniometry 175
Cephalometrics and Growth 182
Standardizing the Cephalograms for Comparison 186
Application of Cephalometrics in Growth and Development 187

12. Growth Prediction 194
Need for Growth Prediction 194
Methods of Prediction 195

13. Growth Rotations 220
Implant Radiography 220
Mandibular Growth Rotations 221
Bjork's (1969) Classification 221
Bjork and Skeiller's Method 223
Schudy's Concept 224
Dibbets' Concept 226
Proffit's Description of Rotation 227
Growth Rotation of Maxilla 228
Jaw Rotation and Tooth Eruption 230
Mutual Relationship of Rotating Jaw Bases 230
Studies on Growth Rotations 232
Cephalometric Diagnosis in Growth Rotation 234

14. Growth Patterns in Skeletal Malocclusion 236
Growth Pattern in Vertical Skeletal Disproportions 236
Growth Pattern of Skeletal Class II Malocclusion 241
Growth Pattern of Class III Malocclusions 245
Sexual Dimorphism in Various Malocclusions 247
Position of Glenoid Fossa in Different Facial Types 248

15. Growth and Craniofacial Anomalies ... 251
Development of Craniofacial Primordia 251
Neural Crest Cells 252
Ganglionic Placodal Cells 253
Patterning Branchial Arches in Head 254
Homeobox Genes 254
Developmental Anomalies 255
Abnormal Growth Patterns 259

16. Growth Considerations in Stability of Orthodontic Treatment 262
Changes related to growth 262

17. Temporomandibular Joint 266
Anatomy of Temporomandibular Joint 267
Embryology 271
Histology 272

Origin and Evolution 275
Condylar Growth and Glenoid Fossa Displacement during Growth and in Malocclusion 277

18. Myology and Neuromuscular Reflexes 279
Muscle 279
Skeletal Muscle 280
Development of Muscle and Muscle Changes During Growth 283
Skeletal Muscles in the Craniofacial Region 284
Form and Function 285
Research Methodology Regarding Form and Function—Factors Controlling Facial Growth 287
Reflex Control of Jaw Muscles 291

19. Maturation of Orofacial Functions 299
Respiration 300
Swallowing or Deglutition 301
Mastication 305
Speech 308

20. Genetics and Craniofacial Growth 312
DNA 313
Gene 314
Regulation of Gene Expression 314
Up-regulation and Down-regulation 315
Mutation 316
Mendelian Genetics 317
Modes of Inheritance 317
Multifactorial Inheritance 319
Twin Studies 320
Limitations of Twin Studies 324
Methods of Transmission of Malocclusion 324
Molecular Approach to Growth 324
Growth Factors 324
Trilaminar Germ Disk 326
Neural Crest Cells 327
The Role of Homeobox Genes 328
Craniofacial Development 329
Craniofacial Defects 335
Future of Molecular Research in Craniofacial Growth 338

21. Emotional Growth 342
Schools of Psychology 342
The Dynamics of Emotional Development From Infant to Adult 343
Theories of Emotional Development 346
Habit Intervention and Emotional Growth 366
The Role of Malocclusion in Psychological Development 367
Emotional Development and its Relation to Cooperation in Treatment 371

Index **373**