

Table of Contents

Part I Foundation Concepts

1	Principles of Kinesiology and Biomechanics	3
	Directional Terms	4
	Osteokinematics	5
	Planes of Motion	5
	Axis of Rotation	7
	Osteokinematic Movement Terminology	8
	Degrees of Freedom	8
	Kinematics	9
	Linear Motion	10
	Rotary Motion	11
	General Motion	11
	Kinematic Chains of Motion	11
	Forces	14
	Internal Forces	15
	External Forces	16
	Types of Forces	16
	Influence of Forces	17
	Vectors	17
	Torques	22
	Force Couples	24

2	Additional Biomechanical Principles	31
	Newton's Laws of Motion	32
	Newton's First Law of Motion: The Law of Inertia	32
	Newton's Second Law of Motion: The Law of Acceleration	34
	Newton's Third Law of Motion: The Law of Action–Reaction	35
	Work–Energy Relationships	36
	Potential and Kinetic Energy	37
	Power	37
	Lever Systems	37
	First-Class Levers	38
	Second-Class Levers	38
	Third-Class Levers	38
	Mechanical Advantage	38
	Anatomical Pulleys	41
3	Structure and Function of Joints	45
	Skeletal System Functions	46
	Joint Composition	47
	Tissue and Cellular Components	47
	Structural Components	48
	Joint Classification	52
	Structural Classification	52
	Functional and Movement Classification	56

Joint Movement	57
Osteokinematics	57
Arthrokinematics	57
4 Structure and Function of Muscles	65
Muscle Structure	66
Cellular Components	66
Muscle Contraction (Activation)	69
Cross-Bridge Links	69
Muscle Action Terminology	69
Types of Contraction	71
The Motor Unit	72
Muscle Architecture	75
Fiber Arrangement	75
Fiber Type	76
Muscle Length-Tension Relationships	78
Passive Length-Tension Relationship	79
Active Length-Tension Relationship	80
Total Length-Tension Relationship	80
Muscle Excursion	80
Force-Velocity Relationship	81
Stress-Strain Relationship	82
Neural Structures and Motor Output	83
Sensory Pathways	84
Sensory Receptors	85
Skeletal Muscle Changes Related to Age and Inactivity	86
Inactivity	88

Part II The Vertebral Column

5 Structure and Function of the Spine	93
Spinal Structures	94
Spinal Curves	94
Vertebrae	94
Spinal Kinematics	101
Regional Spinal Characteristics	102
Cervical Region	102

Thoracic Region	104
Lumbar Region	108
Sacral Region	108
Spinal Muscles	112
Posterior Spinal Muscles	112
Anterior Spinal Muscles	113
Spinal Muscle Stabilization and Alignment	115

6 Structure and Ventilation Function of the Thorax	121
Structures of the Thorax	122
Sternum	122
Ribs	122
Ventilation	123
Kinematics During Ventilation	124
Muscles of Ventilation	126
Muscles of Quiet Ventilation	126
Muscles of Forced Inspiration	128
Muscles of Forced Expiration	130
Ventilation System Changes Related to Aging and Disease	131
Age-Related Changes	131
Disease-Related Changes	132
7 Structure and Function of the Temporomandibular Joint	135
Joint Structures	136
Bone and Disc Structures	136
Capsule and Ligaments	136
Kinematics	136
Mandibular Depression and Elevation	137
Mandibular Protrusion and Retrusion	138
Mandibular Lateral Excursion	140
Muscles	140
Primary Muscles	140
Secondary Muscles	141
Temporomandibular Joint Dysfunction Related to Aging and Disease	142

Appendix A Attachments and Innervation of the Muscles and Structures of the Axial Skeleton 145

Spinal Cord Structures 146

Thoracic Dermatomes of the Trunk 147

Muscles of the Trunk 147

Muscles of the Posterior Trunk 147

Muscles of the Anterior-Lateral Trunk 148

Muscles of the Craniocervical Region 148

Miscellaneous: Quadratus Lumborum 149

Primary Muscles of Mastication 149

Masseter: Combined Superficial and Deep Heads 149

Temporalis 149

Medial Pterygoid: Combined Superficial and Deep Heads 149

Lateral Pterygoid (Superior Head) 149

Lateral Pterygoid (Inferior Head) 149

Suprahyoid Muscles 149

Digastric: Posterior Belly 149

Digastric: Anterior Belly 150

Geniohyoid 150

Mylohyoid 150

Stylohyoid 150

Infrahyoid Muscles 150

Omoxyoid 150

Sternohyoid 150

Thyrohyoid 150

Muscles Related Primarily to Ventilation 150

Diaphragm 150

External Intercostals 150

Internal Intercostals 150

Subcostal 151

Levatores Costarum (Longus and Brevis) 151

Serratus Posterior Inferior 151

Serratus Posterior Superior 151

Scalene Muscles 151

Transversus Thoracis 151

Part III The Upper Extremity

8 Structure and Function of the Shoulder Complex 155

Shoulder Complex Structures 157

Bones 157

Joints 158

Shoulder Complex Kinematics 167

Scapulothoracic and Glenohumeral Contributions 167

Sternoclavicular and Acromioclavicular Contributions 170

Shoulder Complex Muscles 171

Scapulothoracic Joint Muscles 171

Glenohumeral Joint Muscles 172

Functional Deficits in the Shoulder Complex 175

9 Structure and Function of the Elbow Complex 181

Elbow Complex Structures 182

Bony Structures 182

Joints 183

Elbow Complex Muscles 188

Elbow Flexors 188

Elbow Extensors 191

Forearm Supinators and Pronators 193

Muscle Recruitment During Functional Activities 194

10 Structure and Function of the Wrist and Hand Complex 197

Wrist Complex Structures 198

Bony Structures 198

Joint and Ligament Structures 199

Carpal Tunnel 199

Kinematics 200

Muscles 201

Hand Complex Structures	205
Bony Structures	205
Joint Structures	206
Ligament and Connective Tissue Structures	207
Muscles	210
Functional Use of the Wrist and Hand	218
Functional Position	218
Prehension	219
Appendix B Attachments and Innervation of the Muscles and Structures of the Upper Extremity	223
Brachial Plexus	224
Peripheral Nerves of the Upper Extremity	224
Shoulder Complex Musculature	224
Coracobrachialis	224
Deltoid	224
Infraspinatus	224
Latissimus Dorsi	224
Levator Scapula	227
Pectoralis Major	227
Pectoralis Minor	227
Rhomboid Major and Minor	227
Serratus Anterior	227
Subclavius	227
Subscapularis	227
Supraspinatus	227
Teres Major	227
Teres Minor	227
Trapezius	228
Elbow and Forearm Musculature	228
Anconeus	228
Biceps Brachii	228
Brachialis	228
Brachioradialis	228
Pronator Teres	228
Pronator Quadratus	228
Supinator	228
Triceps Brachii	228

Wrist Musculature	228
Extensor Carpi Radialis Brevis	229
Extensor Carpi Radialis Longus	229
Extensor Carpi Ulnaris	229
Flexor Carpi Radialis	229
Flexor Carpi Ulnaris	229
Palmaris Longus	229
Extrinsic Hand Musculature	229
Abductor Pollicis Longus	229
Extensor Digitorum	230
Extensor Digiti Minimi	230
Extensor Indicis	230
Extensor Pollicis Brevis	230
Extensor Pollicis Longus	230
Flexor Digitorum Profundus	230
Flexor Digitorum Superficialis	230
Flexor Pollicis Longus	230
Intrinsic Hand Musculature	230
Abductor Digiti Minimi	230
Abductor Pollicis Brevis	231
Adductor Pollicis	231
Dorsal Interossei	231
Flexor Digiti Minimi	231
Flexor Pollicis Brevis	231
Lumbricals	231
Opponens Digiti Minimi	231
Opponens Pollicis	231
Palmaris Brevis	231
Palmar Interossei	231

Part IV The Lower Extremity

11 Structure and Function of the Hip Complex	235
Hip Complex Structures	236
Bony Structures	236
Joint Structures	240
Joint Capsule, Ligaments, and Bursae	241

Kinematics	243		
Osteokinematics	243		
Arthrokinematics	245		
Hip Complex Muscles	246		
Flexors	246		
Adductors	250		
Extensors	251		
Abductors	252		
Lateral Rotators	253		
Medial Rotators	254		
12 Structure and Function of the Knee	257		
Knee Structures	258		
Bony Structures	258		
Joint Structures	261		
Kinematics	267		
Osteokinematics	267		
Arthrokinematics	272		
Muscles	275		
Knee Extensors	275		
Knee Flexors and Rotators	276		
Influence of Hip Position on Knee Function	280		
Knee Extension With Hip Flexion	280		
Knee Flexion With Hip Extension	280		
Knee Flexion With Hip Flexion	281		
Knee Extension With Hip Extension	281		
13 Structure and Function of the Ankle and Foot Complex	285		
Bony Structures	287		
Tibia	287		
Fibula	287		
Talus	287		
Calcaneus	287		
Navicular, Cuneiforms, and Cuboid	287		
Metatarsals and Phalanges	287		
Joint Structures	288		
Proximal and Distal Tibiofibular Joints	288		
		Talocrural Joint	289
		Subtalar Joint	290
		Transverse Tarsal Joint	292
		Tarsometatarsal Joints	295
		Intermetatarsal Joints	295
		Metatarsophalangeal and Interphalangeal Joints	296
		Foot Arches	296
		Muscles	298
		Anterior Muscle Group	299
		Posterior Muscle Group	301
		Lateral Muscle Group: Fibularis Longus and Fibularis Brevis	303
		Intrinsic Muscle Group	305
		Functional Performance of the Foot	307
		Pronation and Supination at the Subtalar Joint	307
		Pronation and Supination at the Transverse Tarsal Joint	309
	14 Posture and Function of Gait		313
		Posture	314
		Standing Alignment and Posture	314
		Sitting Alignment and Posture	315
		Deviations From Optimal Posture and Alignment	315
		Gait	316
		The Gait Cycle	317
		Stance Phase	317
		Swing Phase	318
		Limb Support Phases	318
		Spatial Descriptors of Gait	319
		Temporal Descriptors of Gait	319
		Center of Mass Displacement During Gait	320
		Joint Kinematics During Gait	321
		Pelvis	321
		Hip	322
		Knee	322
		Ankle	322

Subtalar Joint	323
First Tarsometatarsal and First Metatarsophalangeal Joints	324
Trunk and Upper Extremities	325
Muscle Activity During Gait	325
Hip and Knee Muscle Activity	325
Ankle and Foot Muscle Activity	325
Atypical Gait Patterns	326
Foot Slap and Foot Drop	326
Gluteus Maximus Lurch	327
Trendelenburg Gait	327
Vaulting, Hip Hiking, and Circumduction Gait	327
Other Gait Patterns	328
Gait and Aging	328
Running	329

Appendix C Attachments and Innervation of the Muscles and Structures of the Lower Extremity 333

Dermatomes of the Lower Extremity	334
Peripheral Nerves of the Lower Extremity	334
Hip and Knee Musculature	334
Adductor Brevis	334
Adductor Longus	334
Adductor Magnus	334
Articularis Genus	335
Biceps Femoris	335
Gemellus Inferior	335
Gemellus Superior	337
Gluteus Maximus	337
Gluteus Medius	337
Gluteus Minimus	337
Gracilis	337
Iliopsoas	337
Iliacus	337
Obturator Externus	337

Obturator Internus	338
Pectineus	338
Piriformis	338
Popliteus	338
Psoas Minor	338
Quadratus Femoris	338
Rectus Femoris	338
Sartorius	338
Semimembranosus	338
Semitendinosus	338
Tensor Fasciae Latae	338
Vastus Intermedius	338
Vastus Lateralis	338
Vastus Medialis	338
Ankle and Foot Musculature	338
Extensor Digitorum Longus	338
Extensor Hallucis Longus	340
Fibularis (Peroneus) Brevis	340
Fibularis (Peroneus) Longus	340
Fibularis (Peroneus) Tertius	340
Flexor Digitorum Longus	340
Flexor Hallucis Longus	340
Gastrocnemius	340
Plantaris	340
Soleus	340
Tibialis Anterior	340
Tibialis Posterior	340
Intrinsic Muscles of the Foot	340
Extensor Digitorum Brevis	340
Layer 1	341
Layer 2	341
Layer 3	341
Layer 4	341
Glossary	343
Index	349