

# CONTENTS

## 1 MOTOR SYSTEM

Matteo Bologna, Antonio Suppa, Alfredo Berardelli

1.1	The skeletal muscle and the neuromuscular junction .....	1
1.2	The peripheral nerve.....	2
1.3	The lower motor neurons (spinal and cranial) .....	2
1.4	Spinal Circuits and reflexes.....	3
1.5	Motor control systems of the brainstem.....	7
1.5.1	The primary motor area and the corticospinal tract .....	9
1.5.2	The non-primary motor areas.....	11
1.5.3	The basal ganglia nuclei .....	11
1.5.4	The cerebellum.....	15
1.6	Motor syndromes .....	16
1.6.1	Signs and symptoms secondary to muscle and neuromuscular junction disorders....	16
1.6.2	Signs and symptoms of peripheral paralysis (lower motor neuron syndrome) .....	18
1.6.3	Signs and symptoms of central paralysis (upper motor neuron syndrome).....	20
1.6.4	Signs and symptoms of non-primary motor area dysfunction .....	23
	Apraxia.....	23
	Other higher-order motor disorders .....	23
1.6.5	Signs and symptoms of basal ganglia dysfunction.....	24
	Hyperkinetic movement disorders.....	25
1.6.6	Signs and symptoms of cerebellar disorders .....	26
1.6.7	Additional signs of motor system involvement.....	28
	Posture, facial expression and gait.....	28
	Bibliography .....	30

## 2 SENSITIVITY

Giulia Di Stefano, Andrea Truini, Giorgio Cruccu

2.1	Somatic sensitivity.....	31
2.1.1	Functional organization .....	31
2.1.2	Peripheral sensory fibers.....	34
2.1.3	Spinotalamic tract .....	34
2.1.4	Dorsal Column Pathway and Dorsolateral Pathway .....	35
2.1.5	Cortical areas .....	35
2.2	Visceral sensitivity .....	36
2.2.1	Sensory examination.....	36
2.3	Neuropathic Pain.....	37

2.4	Sensory syndromes .....	39
2.4.1	Peripheral syndromes.....	39
2.4.2	Central syndromes .....	40
Bibliography .....		41

---

<b>3</b>	<b>CRANIAL NERVES</b>	<b>43</b>
----------	-----------------------	-----------

Mario Manfredi

3.1	Functional organization of the cranial nerves.....	43
3.2	Olfaction and taste .....	45
3.2.1	Smell (olfactory nerve, 1 <sup>st</sup> cranial nerve) .....	45
3.2.2	Taste (facial, glossopharyngeal, and vagus nerves; 7 <sup>th</sup> , 9 <sup>th</sup> , and 10 <sup>th</sup> cranial nerves) ....	47
3.3	Sensibility and motility of the face .....	49
3.3.1	Trigeminal (5 <sup>th</sup> cranial nerve) .....	49
	Sensory contingent .....	49
	Central trigeminal pathways .....	50
	Motor Component.....	51
	Examination of Trigeminal Functions.....	52
	Trigeminal Nerve Lesions.....	52
3.3.2	Facial (7 <sup>th</sup> cranial nerve) .....	54
	Facial Pathology .....	56
3.4	Neuroophthalmology .....	57
3.4.1	Vision .....	57
	Functional organization of the visual pathways.....	57
	Examination of the visual pathways.....	59
	Pathology of the visual pathways.....	62
3.4.2	Extrinsic ocular motility .....	68
	Extrinsic eye muscles .....	68
	Nuclei and Oculomotor Nerves.....	69
	Supranuclear Oculomotor Systems .....	70
	Examination of eye motility .....	72
	Eye movement disorders .....	74
3.4.3	Intrinsic Ocular Motility .....	76
	Functional Organization of the Pupils .....	76
	Examination of the pupils .....	78
	Pupillary Syndromes .....	78
3.5	Neurotology .....	79
3.5.1	Vestibular System.....	80
	Functional organization.....	80
	Vestibular Reflexes.....	82
	Examination of the Vestibular System .....	84
	Vestibular Syndromes.....	85
	Pathology of the Vestibular System .....	86
3.5.2	Acoustic System .....	90
	Functional organization.....	90
	Pathophysiology of hearing disorders .....	92
	Examination of auditory function.....	92
	Pathology of the auditory system .....	94
3.6	Cranial bulbar nerves.....	95
3.6.1	Glossopharyngeal (9 <sup>th</sup> ), Vagus (10 <sup>th</sup> ) and cranial root of the accessory (11 <sup>th</sup> ) .....	95
3.6.2	Spinal accessory nerve (11 <sup>th</sup> cranial nerve) .....	98
3.6.3	Hypoglossal nerve (12 <sup>th</sup> cranial nerve).....	100
Bibliography .....		100

<b>4 ANATOMICAL BASES OF COGNITIVE PROCESSES</b>	<b>101</b>
Marco Canevelli, Fabrizia D'Antonio, Alessandro Trebbastoni, Giuseppe Bruno	
Primary Cortices .....	101
Unimodal Associative Areas .....	101
Heteromodal associative areas .....	101
4.1 Memory .....	102
4.2 Executive functions.....	104
4.3 Attention.....	105
4.4 Language.....	105
4.5 Praxic functions .....	107
4.6 Gnostic functions .....	108
4.6.1 Visual Agnosias .....	109
4.6.2 Auditory Agnosias.....	109
4.6.3 Tactile Agnosia .....	109
4.7 Body Schema.....	109
4.8 Neuropsychological Assessment .....	110
4.8.1 Diagnostic Question .....	111
4.8.2 Procedural Aspects.....	112
Bibliography .....	113
<b>5 NEURORADIOLOGY DIAGNOSTICS AND THERAPEUTICS</b>	<b>117</b>
Patrizia Pantano, Costanza Giannì, Claudio Colonnese, Marco Fiorelli	
5.1 Computed Tomography.....	117
5.1.1 Angio-TC.....	118
5.1.2 Cerebral Perfusion .....	118
5.2 Magnetic Resonance Imaging .....	119
5.2.1 Angio-RM.....	120
5.2.2 Diffusion MRI .....	120
5.2.3 Perfusion MRI.....	122
5.2.4 RM in Spectroscopy .....	122
5.2.5 Functional Magnetic Resonance Imaging (fMRI).....	122
5.3 Cerebral Angiography .....	123
5.4 Spinal Angiography .....	125
5.5 Interventional Neuroradiology .....	125
5.5.1 Carotid Stenting.....	125
5.5.2 Endovascular Treatment of Aneurysms .....	125
5.5.3 Treatment of Arteriovenous Malformations (AVMs).....	126
5.5.4 Endovascular Treatment of Ischemic Stroke .....	126
5.5.5 Treatment of painful vertebral fractures through vertebroplasty .....	126
5.6 Main clinical indications .....	126
5.6.1 Brain tumors.....	126
5.6.2 Cerebrovascular Diseases.....	129
5.6.3 Cranial Trauma.....	131
5.6.4 Infectious Pathologies .....	132
5.6.5 Multiple Sclerosis.....	133
5.6.6 Degenerative Diseases .....	134
5.6.7 Epilepsy.....	135
5.6.8 Study of the Spinal Column .....	136
Bibliography .....	137

---

**6 CEREBROSPINAL FLUID (CSF) ANALYSIS**

139

Renzo Guglielmi

6.1	Cerebrospinal Fluid .....	139
6.1.1	Physiology and Pathophysiology .....	139
6.1.2	Cerebrospinal Fluid Pressure.....	142
6.1.3	Barriers between blood, brain, and cerebrospinal fluid and their functions.....	142
6.1.4	Cerebrospinal Fluid Withdrawal .....	143
6.1.5	Cerebrospinal Fluid Examination .....	144
6.1.6	Oligoclonal Band Search .....	148
6.1.7	Quantification of specific antiviral antibody synthesis in cerebrospinal fluid .....	150
6.2	Autoimmune diseases of the nervous system .....	150
6.2.1	Research and demonstration of specific proteins.....	153
6.2.2	Bacteriology and Virology .....	155
	Bibliography .....	158

---

**7 ELECTROENCEPHALOGRAPHY AND RELATED TECHNIQUES**

159

Oriano Mecarelli, Patrizia Pulitano, Edoardo Vicenzini

7.1	EEG Execution Techniques .....	160
7.2	General characteristics of physiological EEG signals and patterns.....	161
7.3	Pathological EEG Patterns .....	165
7.4	Activation tests.....	167
7.5	Poligraphy and Special EEG Recordings .....	168
	Bibliography .....	169

---

**8 ELECTRONEUROGRAPHY, ELECTROMYOGRAPHY AND EVOKED POTENTIALS**

171

Antonella Conte, Andrea Truini, Maurizio Inghilleri, Alfredo Berardelli

8.1	Electroneurography and electromyography .....	171
8.1.1	Electroneurography .....	171
8.1.2	Study of repetitive nerve stimulation .....	174
8.1.3	Electromyography .....	174
8.1.4	Trigeminal reflexes .....	179
8.2	Evoked Potentials .....	180
8.2.1	Visual Evoked Potentials (VEPs).....	180
8.2.2	Auditory evoked potentials.....	181
8.2.3	Somatosensory evoked potentials (SEP) .....	182
8.2.4	Motor evoked potentials (MEP) .....	182
8.2.5	Laser Evoked Potentials (LEP).....	183
	Bibliography .....	184

---

**9 NEUROSONOLOGY**

185

Edoardo Vicenzini

9.1	Principles of ultrasound imaging .....	185
9.2	Doppler effect and velocimetry .....	185
9.3	Eco-color-Doppler .....	186
9.3.1	Eco-color-Doppler of the supra-aortic vessels .....	186
9.3.2	Transcranial Doppler and Transcranial Color-Doppler.....	191
	Bibliography .....	194

<b>10</b>	<b>CONSCIOUSNESS AND ITS DISORDERS</b>	<b>197</b>
Francesco Orzi, Michele Cavallari, Marco Salvetti		
10.1	Anatomical bases of consciousness .....	198
10.1.1	Vigilance .....	198
10.1.2	Consciousness content.....	199
10.2	Coma.....	199
10.2.1	Causes .....	199
10.2.2	Diagnosis.....	201
10.2.3	Evaluation and treatment of comatose patients .....	206
10.2.4	Prognosis.....	207
10.3	Vegetative state and minimally conscious state .....	208
10.3.1	Diagnosis.....	208
10.3.2	Differential Diagnosis.....	209
10.3.3	Clinical case report.....	209
10.4	Delirium.....	210
10.4.1	Diagnosis.....	210
10.4.2	Causes .....	211
	Bibliography .....	212
<b>11</b>	<b>METABOLIC ENCEPHALOPATHIES</b>	<b>213</b>
Antonio Currà, Francesco Fattapposta		
11.1	Acute metabolic encephalopathy .....	213
11.1.1	Pathophysiology of encephalopathy .....	214
11.1.2	Clinical and instrumental semiotics .....	215
11.2	Specific patterns of metabolic or toxic encephalopathy.....	216
11.2.1	Hypoglycemic encephalopathy .....	216
11.2.2	Hyperglycemic encephalopathy .....	218
11.2.3	Hepatic encephalopathy .....	219
11.2.4	Renal functional failure encephalopathy.....	223
11.2.5	Pulmonary functional failure encephalopathies .....	225
	Bibliography .....	229
<b>12</b>	<b>EPILEPSY</b>	<b>231</b>
Carlo Di Bonaventura, Alessandra Morano, Anna Teresa Giallonardo, Jinane Fattouch, Alfredo Berardelli		
12.1	Epidemiology.....	231
12.2	Etiology.....	232
12.3	Pathophysiology .....	236
12.4	Clinical aspects and classification.....	238
12.5	Classification by type of seizure .....	238
12.5.1	Focal Onset Seizures .....	238
	Motor onset focal seizures.....	240
	Focal seizures with non-motor onset .....	241
12.5.2	Generalized onset seizures .....	242
	Motor Generalized Seizures .....	242
	Generalized non-motor seizures .....	243
12.5.3	Unknown onset seizures.....	243
12.5.4	Unclassified Seizures .....	244
12.6	Classification of epilepsy types and epileptic syndromes .....	244

---

12.6.1	Focal Epilepsies .....	244
	Structural, metabolic, infectious, and immune focal epilepsies .....	244
	Focal genetic epilepsies (or idiopathic).....	246
12.6.2	Generalized epilepsies .....	247
	Idiopathic and genetic generalized epilepsies.....	247
	Focal and generalized combined epilepsies (or symptomatic generalized epilepsies) 248	
	Focal epilepsies of unknown etiology .....	249
12.7	Diagnosis .....	249
12.8	Therapy .....	251
12.9	Epilepsy as a neurological emergency: status epilepticus.....	257
	Bibliography .....	258

---

13	CEREBROVASCULAR DISEASES	259
----	--------------------------	-----

Francesco Orzi, Danilo Toni

13.1	Vascular anatomy of the brain .....	259
13.2	Epidemiology.....	261
13.3	Ischemic stroke .....	261
13.3.1	Prognosis and risk factors .....	261
13.3.2	Pathophysiology .....	263
13.3.3	Etiopathogenesis.....	266
13.3.4	Clinical aspects.....	267
13.4	Transient ischemic attack .....	269
13.5	Transient global amnesia (TGA) .....	270
13.5.1	Differential diagnosis .....	271
13.5.2	Diagnostic-therapeutic pathway.....	272
13.5.3	Therapy.....	277
13.6	Stroke from rare causes.....	284
13.6.1	Arterial dissection .....	284
13.6.2	Vasculitis.....	286
13.6.3	Hematological disorders .....	288
13.6.4	Susac syndrome .....	289
13.6.5	Sneddon's syndrome .....	290
13.6.6	Mitochondrial diseases .....	290
13.6.7	Fabry disease.....	291
13.6.8	CADASIL.....	292
13.6.9	Moya-moya disease .....	292
13.6.10	Migrainous stroke.....	293
13.6.11	Atrial septal abnormalities.....	293
13.6.12	Drug and substance abuse .....	293
13.6.13	Cerebral venous thrombosis .....	294
13.6.14	Posterior reversible encephalopathy syndrome (PRES) .....	296
13.6.15	Marfan syndrome .....	296
13.6.16	Ehlers-Danlos Syndrome .....	297
13.6.17	Loeys-Dietz syndrome.....	298
13.6.18	Tortuous artery syndrome.....	298
13.6.19	Pseudoxanthoma elasticum.....	299
13.6.20	Fibromuscular Dysplasia .....	299
13.7	Intracerebral hemorrhage .....	299
13.7.1	Epidemiology and risk factors .....	299
13.7.2	Pathogenesis.....	301
13.7.3	Pathophysiology .....	302

---

13.7.4	Clinical aspects.....	303
13.7.5	Diagnosis.....	304
13.7.6	Treatment.....	307
13.7.7	Specific therapies .....	308
13.8	Subarachnoid Hemorrhage (SAH) .....	308
13.8.1	Epidemiology and risk factors .....	308
13.8.2	Pathogenesis.....	309
13.8.3	Clinical aspects.....	310
13.8.4	Diagnosis.....	311
13.8.5	Treatment.....	313
13.9	Spinal cord vascular pathology .....	314
13.9.1	Vascular anatomy .....	314
13.9.2	Spinal cord infarction .....	315
13.9.3	Spinal cord hemorrhage.....	316
13.9.4	Vascular malformations .....	316
	Bibliography .....	317

---

**14 NEUROSURGICAL APPROACH TO INTRACEREBRAL HEMORRHAGES** 319

Antonio Santoro, Luigi Valentino Berra

14.1	Clinical presentation.....	319
14.2	Diagnosis .....	320
14.3	Complications and treatment .....	321
14.4	Prognosis .....	323
	Bibliography .....	324

---

**15 MOVEMENT DISORDERS** 325

Giovanni Fabbrini, Carlo Colosimo, Daniele Belvisi, Alfredo Berardelli

15.1	Hypokinetic syndromes .....	325
15.1.1	Parkinson's disease .....	325
	Epidemiology .....	325
	Pathological anatomy.....	325
	Etiopathogenesis and pathophysiology .....	326
	Clinical features.....	329
	Diagnosis.....	331
	Treatment .....	332
15.1.2	Atypical and secondary parkinsonisms .....	336
	Multiple System Atrophy (MSA) .....	337
	Progressive Supranuclear Palsy (PSP).....	337
	Corticobasal degeneration (CBD) and corticobasal syndrome (CBS).....	337
15.1.3	Secondary parkinsonisms.....	338
15.2	Hyperkinetic syndromes .....	339
15.2.1	Tremor .....	339
	Essential tremor .....	341
15.2.2	Dystonia .....	342
15.2.3	Chorea .....	346
	Huntington's disease.....	346
	Other genetically determined choreas .....	347
	Secondary choreas.....	348
15.2.4	Ballism .....	348

---

15.2.5 Tic.....	348
15.2.6 Acathisia .....	349
15.2.7 Athetosis .....	349
15.2.8 Wilson's disease.....	349
15.2.9 Stereotypies .....	351
15.2.10 Myoclonus .....	351
15.2.11 Stiff person syndrome.....	351
15.2.12 Myokimia.....	352
15.2.13 Facial spasm.....	352
15.2.14 Restless legs syndrome.....	353
15.2.15 Functional Movement Disorders .....	353
15.2.16 Cerebellar ataxias .....	353
Acquired cerebellar ataxia.....	354
Atassie ereditarie .....	355
X-Linked .....	358
Ataxias caused by vitamin E deficiency .....	358
Sporadic ataxias.....	358
Bibliography .....	358

---

**16 NEUROCOGNITIVE DISORDERS AND DEMENTIAS** 359

Fabrizia D'Antonio, Marco Canevelli, Alessandro Trebbastoni, Giuseppe Bruno, Carlo De Lena

16.1 Definition and theoretical background .....	359
16.2 Neurodegenerative dementias .....	361
16.2.1 Alzheimer's disease.....	361
Neuropathology .....	361
Genetics.....	363
Clinical picture .....	363
Diagnostic tools.....	368
Clinical variants of alzheimer's disease.....	369
Therapy .....	370
16.2.2 Lewy body disease.....	371
Neuropathology .....	372
Epidemiology .....	372
Clinical picture .....	372
Diagnostic tools.....	373
16.2.3 Parkinson's dementia.....	374
Clinical picture .....	374
Treatment .....	374
16.2.4 Frontotemporal dementias .....	375
Genetics and neuropathology.....	375
Clinical presentation .....	376
Instrumental exams .....	377
Therapy .....	377
16.2.5 Atypical parkinsonisms .....	377
16.2.6 Huntington's disease .....	378
16.3 Secondary dementias .....	378
16.3.1 Vascular cognitive disorders .....	378
Clinical picture .....	379
Instrumental examinations .....	379
Therapy .....	380
16.3.2 Normotensive hydrocephalus.....	381

---

Pathogenesis .....	381
Clinical presentation .....	381
Instrumental examinations .....	381
Treatment .....	381
16.3.3 Malattie da prioni .....	382
Neuropathology .....	382
Clinical picture .....	382
Diagnostic tests .....	382
Therapy .....	382
16.3.4 Alcohol-related dementia .....	382
16.3.5 HIV/AIDS-related dementia .....	383
16.3.6 "Reversible" dementias .....	383
16.4 Behavioral disorders .....	383
Bibliography .....	386

---

<b>17 MULTIPLE SCLEROSIS</b>	<b>387</b>
------------------------------	------------

Marco Salvetti, Giulia Coarelli, Silvia Romano, Antonella Conte	
17.1 Etiology .....	387
17.2 Pathological anatomy .....	388
17.3 Clinical aspects of multiple sclerosis .....	389
17.4 Course and prognosis .....	391
17.5 Diagnosis .....	392
17.6 Differential diagnosis .....	394
17.7 Treatment .....	396
Bibliography .....	397

---

<b>18 THE SLEEP AND ITS DISORDERS</b>	<b>399</b>
---------------------------------------	------------

Carlo Di Bonaventura, Jinane Fattouch, Anna Teresa Giallonardo	
18.1 Definitions .....	399
18.2 Anatomic, physiological, and neurobiological bases of sleep .....	399
18.3 Sleep-wake cycle .....	400
18.4 Functional significance of sleep .....	400
18.5 Sleep structure and instrumental investigations .....	401
18.6 Sleep disorders .....	402
Definitions and classification .....	402
18.6.1 Insomnia .....	403
18.6.2 Sleep-related breathing disorders .....	404
Obstructive sleep apnea/hypopnea syndrome .....	404
Central sleep apnea syndrome .....	404
18.6.3 Central disorders of hypersomnolence .....	405
Narcolepsy and cataplexy .....	405
Hypersomnia .....	406
18.6.4 Circadian rhythm sleep-wake disorders .....	406
18.6.5 Parasomnias .....	406
NREM-Related Parasomnias .....	406
REM-related parasomnias .....	407
18.6.6 Sleep-related movement disorders .....	407
Restless leg syndrome .....	408
Periodic limb movement disorder .....	408
18.6.7 Other sleep disorders in neurological conditions and differential diagnosis .....	408
Bibliography .....	409

<b>19</b>	<b>MOTOR NEURON DISEASES (MND)</b>	<b>411</b>
Marco Ceccanti, Chiara Cambieri, Laura Libonati, Maurizio Inghilleri		
19.1	Etiology and pathophysiology .....	412
19.2	Clinical aspects and classification.....	414
19.3	Other forms of lower motor neuron (LMN) disease.....	417
19.4	Diagnosis .....	417
19.5	Therapy .....	419
	Bibliography .....	420
<b>20</b>	<b>PERIPHERAL NERVOUS SYSTEM DISEASES</b>	<b>423</b>
Andrea Truini, Giulia Di Stefano, Giorgio Cruccu 423		
20.1	Clinical overview .....	423
20.1.1	Overview of peripheral nerve anatomy .....	423
20.1.2	Symptoms and general signs of peripheral nervous system diseases.....	423
20.1.3	Neuropathological classification of neuropathies .....	424
20.1.4	Topographic classification .....	425
20.1.5	Diagnostic test examinations .....	426
20.2	Mononeuropathies .....	427
20.2.1	Plexus pathology .....	427
	Brachial plexus .....	427
	Lumbosacral plexus.....	429
20.2.2	Syndromes due to individual nerve trunk lesions .....	430
20.3	Polyneuropathies.....	436
20.3.1	Hereditary neuropathies .....	436
	Charcot-Marie-Tooth disease (CMT) and related neuropathies .....	436
	Hereditary sensory neuropathies (HSNs) and sensory-autonomic neuropathies (HSANs).....	438
	Hereditary motor neuropathies (dHMN) .....	438
	Involvement of cranial nerves.....	439
	Hereditary metabolic neuropathies.....	439
	Genetically determined small fiber neuropathies .....	440
20.3.2	Neuropathies associated with systemic disease.....	440
	Diabetic neuropathies.....	440
	Neuropathy secondary to hypothyroidism .....	442
	Secondary neuropathy due to acromegaly .....	442
	Peripheral nervous system diseases in the course of renal failure .....	442
20.3.3	Neuropathies in the course of infectious diseases .....	443
20.3.4	Neuropathies in oncological diseases .....	445
20.3.5	Monoclonal gammopathy-associated neuropathies .....	447
20.3.6	Secondary neuropathies associated with autoimmune diseases .....	448
20.3.7	Toxic neuropathies .....	450
20.3.8	Deficiency neuropathies .....	451
20.3.9	Critical illness neuropathy.....	451
20.3.10	Inflammatory neuropathies .....	451
	Guillain-Barré syndrome .....	451
	Miller Fisher syndrome and clinical variants.....	452
	Chronic demyelinating polyradiculoneuropathy .....	453
	Multifocal motor neuropathy .....	453
	Lewis Sumner disease .....	454
	Bibliography .....	454

<b>21</b>	<b>MYOPATHIES AND DISEASES OF THE NEUROMUSCULAR JUNCTION</b>	<b>455</b>
Matteo Garibaldi, Laura Fionda, Stefania Morino, Giovanni Antonini		
21.1	Myopathies .....	455
	Functional and metabolic organization of skeletal muscle.....	455
	Neurophysiology of muscle contraction .....	457
	Muscle metabolism.....	458
	Diagnosis of myopathies.....	459
	Laboratory tests.....	463
	Classification of myopathies .....	464
21.2	Genetic myopathies.....	465
21.2.1	Dystrophinopathies .....	467
	Instrumental diagnosis .....	468
21.2.2	Myotonic dystrophies (DM1, DM2).....	469
21.2.3	Facioscapulohumeral muscular dystrophy (FSHD).....	471
21.2.4	Oculopharyngeal muscular dystrophy (OPMD).....	472
21.2.5	Limb girdle muscular dystrophies (LGMD) .....	473
21.2.6	Congenital muscular dystrophy (CMD) .....	473
21.2.7	Myofibrillar myopathies (MFM) and distal myopathies .....	474
21.2.8	Congenital myopathies .....	475
21.2.9	Tubular aggregate myopathies .....	476
21.2.10	Metabolic myopathies .....	477
	Mitochondrial myopathies .....	477
	Glycogen storage diseases (GSD).....	478
	Fatty acid oxidation disorders (FAOD).....	480
21.2.11	Channelopathies.....	481
21.3	Acquired myopathies .....	483
21.3.1	Inflammatory myopathies.....	483
	Classification .....	483
	Idiopathic inflammatory myopathies (IIM) .....	484
21.3.2	Toxic myopathies.....	488
21.4	Neuromuscular junction disorders (NMJD) .....	488
	The neuromuscular junction.....	488
	Function of the neuromuscular junction .....	490
	Classification of neuromuscular junction disorders .....	490
21.4.1	Myasthenia gravis.....	490
21.4.2	Lambert-Eaton Myasthenic Syndrome (LEMS) .....	496
21.4.3	Botulism.....	497
21.4.4	Congenital myasthenic syndromes (CMS).....	497
	Bibliography .....	498
<b>22</b>	<b>DISEASES OF THE AUTONOMIC NERVOUS SYSTEM</b>	<b>499</b>
Antonella Conte, Alfredo Berardelli		
22.1	Functional organization .....	500
22.2	Functions regulated by the autonomic nervous system .....	502
22.3	Clinically relevant autonomic symptoms .....	504
22.4	Investigative methods .....	504
22.5	Diseases of the autonomic nervous system .....	506
22.5.1	Primary autonomic nervous system diseases .....	506
22.5.2	Secondary autonomic nervous system diseases.....	507
22.5.3	Diseases of the autonomic nervous system: district disorders .....	508

Cardiovascular system dysfunction .....	508
Genitourinary dysfunction .....	509
Bowel dysfunction .....	511
Sexual dysfunction .....	512
<b>Bibliography .....</b>	<b>512</b>

## 23 CEPHALALGIAS

Laura Di Clemente, Marta Altieri, Vittorio Di Piero

23.1 Classification .....	513
23.2 Primary cephalgias .....	513
23.2.1 Migraine .....	513
Pathogenesis .....	513
Clinical and diagnostic aspects .....	515
Treatment .....	518
23.2.2 Tension-type headache .....	521
Pathogenesis .....	521
Clinical and diagnostic aspects .....	521
Therapy .....	522
23.2.3 Cluster headache and other autonomic-trigeminal headaches .....	522
23.2.4 Cluster headache .....	523
Pathogenesis .....	523
Clinical and diagnostic aspects .....	523
Therapy .....	524
23.2.5 Paroxysmal hemicrania .....	525
23.2.6 SUNCT syndrome .....	525
23.2.7 "Hemicrania continua" .....	525
23.2.8 Other primary headaches .....	525
23.3 Secondary headaches .....	526
23.3.1 Headache attributed to cranial and/or cervical trauma .....	526
23.3.2 Headache attributed to cranial or cervical vascular disorders .....	526
23.3.3 Headache attributed to nonvascular intracranial disorders .....	527
23.3.4 Headache attributed to substance use or withdrawal .....	527
23.3.5 Headache attributed to infection .....	528
23.3.6 Headache attributed to homeostatic disturbances .....	528
23.3.7 Headache or facial pain attributed to cranial, neck, eye, ear, nasal, paranasal sinus, dental, oral, or other facial or cranial disorders .....	528
23.3.8 Headache attributed to psychiatric disorders .....	529
23.3.9 Cranial neuralgias .....	529
<b>Bibliography .....</b>	<b>529</b>

## 24 MENINGITIS AND OTHER INFECTIONS OF THE NERVOUS SYSTEM

Giovanni Fabbrini, Maria Ciardi, Paolo Vassalini, Alfredo Berardelli

24.1 Acute meningitis .....	531
24.1.1 Bacterial meningitis .....	531
Epidemiology .....	531
Etiology and pathogenesis .....	531
Symptoms .....	532
Diagnosis .....	533
Differential diagnosis .....	533
Prognosis .....	534

---

Treatment .....	534
24.1.2 Viral meningitis .....	535
Epidemiology .....	535
Etiology .....	535
Symptoms .....	535
Diagnosis .....	536
Differential diagnosis of aseptic meningitis .....	536
Treatment .....	536
Prognosis .....	536
Coronavirus infection and neurological disorders .....	536
Acute neurological disorders .....	536
Chronic neurological disorders .....	537
24.2 Chronic meningitis .....	537
24.2.1 Tuberculous meningitis and other forms of central nervous system tuberculosis .....	538
24.2.2 Neurosyphilis .....	539
24.2.3 Neuroborreliosis (Lyme Disease) .....	539
24.3 Focal infections of the central nervous system .....	540
24.3.1 Cerebral abscess .....	540
24.3.2 Non-bacterial focal infections .....	541
24.3.3 Subdural empyema .....	541
24.3.4 Epidural abscess .....	542
24.3.5 Intracranial thrombophlebitis .....	542
24.4 Other infections of the nervous system .....	542
24.4.1 Poliomyelitis .....	542
24.4.2 Tetanus .....	543
24.4.3 Botulism .....	544
Bibliography .....	545

---

## 25 ENCEPHALITIS 547

Silvia Romano, Marco Salvetti

25.1 Epidemiology .....	547
25.2 Clinical aspects and classification .....	548
25.3 Diagnosis .....	548
25.4 Classification .....	549
25.5 Viral encephalitis .....	550
25.5.1 Herpes virus encephalitis .....	550
Herpes simplex type 1 and type 2 (HSV1 and HSV2) .....	550
Varicella zoster virus .....	551
Epstein-barr virus (EBV) and other herpes virus .....	551
25.5.2 Arbovirus encephalitis .....	552
West Nile virus (WNV) .....	552
Other arboviruses .....	552
25.5.3 Enterovirus Encephalitis (EV) .....	552
25.5.4 (Tick Borne Encephalitis TBE) .....	552
25.5.5 Measles virus encephalitis (Subacute Sclerosing Panencephalitis, SSPE) .....	553
25.5.6 Rabies virus encephalitis .....	553
25.5.7 Progressive multifocal leukoencephalopathy (PML) .....	553
25.5.8 HIV encephalitis .....	553
25.5.9 Encefalite da SARS-CoV-2 .....	554
25.6 Bacterial encephalitis .....	554
25.7 Autoimmune encephalitis .....	554

---

25.8 Limbic Encephalitis .....	555
25.9 Rare forms: Bickerstaff's encephalitis, anti-NMDAR encephalitis, and Rasmussen's encephalitis .....	556
25.10 Transmissible spongiform encephalopathies.....	557
25.10.1 General therapy .....	558
25.10.2 Terapia specifica .....	558
Bibliography .....	559

---

## 26 BRAIN TUMORS 561

Vincenzo Esposito

26.1 Epidemiology and etiology .....	561
26.2 Symptoms.....	562
26.3 Irritative symptoms .....	562
26.4 Intracranial hypertension .....	562
26.5 Neurological syndromes by location (focal signs) .....	565
26.6 Instrumental diagnosis.....	567
26.7 Classification of brain tumors .....	567
26.8 Grades of malignancy.....	568
26.9 Tumor types.....	570
26.10 Extracerebral tumors.....	570
26.10.1 Meningiomas .....	570
26.10.2 Pituitary adenomas.....	571
26.10.3 Craniopharyngiomas .....	572
26.10.4 Vestibular Schwannomas (or acoustic neuromas) .....	572
26.10.5 Chordomas.....	573
26.10.6 Glomus tumors (chemodectomas).....	573
26.10.7 Malignant tumors of the skull base .....	573
26.10.8 Arachnoid cysts(or leptomeningeal cysts).....	573
26.11 Intracerebral tumors.....	573
26.11.1 Gliomas .....	573
26.11.2 Ependymomas .....	575
26.11.3 Cerebral gliomatosis .....	575
26.11.4 Multiple gliomas.....	575
26.11.5 Neuronal and glioneuronal tumors .....	576
26.11.6 Germinoma .....	576
26.11.7 Medulloblastoma.....	576
26.11.8 Hemangioblastoma (or Angioreticuloma).....	576
26.11.9 Epidermoid and dermoid cysts.....	577
26.11.10 Brain metastases.....	577
26.11.11 Cavernous angioma.....	578
26.12 Intraventricular tumors.....	578
26.12.1 Colloid cysts .....	578
26.13 Genetic disorders with associated tumors .....	578
26.13.1 Neurofibromatosis .....	578
26.13.2 Sturge-Weber syndrome .....	579
26.13.3 Von Hippel-Lindau disease.....	579
26.13.4 Tuberous sclerosis .....	580
26.13.5 Benign intracranial hypertension or idiopathic intracranial hypertension (pseudotumor cerebri).....	580
26.14 Treatment .....	581
Bibliography .....	584

<b>27</b>	<b>TRAUMATIC BRAIN INJURY</b>	<b>585</b>
Luca D'Angelo, Roberto Delfini, Antonio Santoro		
27.1	Types of traumatic brain injury .....	585
27.2	Evaluation of the severity of cranial trauma .....	587
27.3	Cranial trauma imaging techniques .....	588
27.4	Main pathological entities resulting from cranial trauma .....	589
27.5	General aspects of therapy useful in patients with severe head trauma or critical conditions	598
27.6	Special types of cranial trauma .....	600
27.7	Pediatric cranial trauma.....	600
	Bibliography .....	601
<b>28</b>	<b>ARTHRITIC, TRAUMATIC, AND ONCOLOGICAL PATHOLOGY OF THE SPINE</b>	<b>603</b>
Francesco Marzetti, Luigi Valentino Berra, Luca D'Angelo, Antonio Santoro		
28.1	Spinal osteoarthritis.....	603
28.1.1	Lumbar-sacral disc herniation.....	603
	Classification .....	603
	Clinical evaluation.....	604
	Other clinical assessments .....	605
28.1.2	Lumbar stenosis.....	606
	Diagnosis .....	606
	Surgical treatment .....	608
28.1.3	Cauda equina syndrome .....	608
	Diagnosis .....	609
	Treatment of CES .....	609
	Surgical treatment .....	609
	Prognosis .....	609
28.1.4	Degenerative dorso-lumbar spondylolisthesis.....	610
	Diagnosis .....	610
	Surgical treatment .....	610
28.1.5	Cervical hernia and stenosis .....	611
	Diagnosis .....	613
	Surgical treatment .....	613
28.1.6	Herniated discs .....	613
	Instrumental examinations .....	614
	Surgical treatment .....	614
28.2	Spinal traumatology .....	614
	Radiological diagnosis .....	616
	Treatment .....	616
28.2.1	Cervical trauma .....	616
	Treatment .....	617
28.2.2	Dorsolumbar trauma .....	618
	Treatment .....	618
28.2.3	Vertebral-spinal cord tumors .....	619
28.2.4	Spinal tumors .....	619
28.2.5	Intradural extramedullary tumors.....	621
28.2.6	Intradural intramedullary tumors.....	622
	Diagnosis .....	623
	Surgical treatment of intramedullary lesions and reduction of surgical risks .....	623
	Therapy .....	624
	Bibliography .....	624

<b>29 CEREBROSPINAL FLUID CIRCULATION DISORDERS</b>	<b>627</b>
Sergio Paolini, Paolo Missori	
29.1 Brief overview of cerebrospinal fluid physiology .....	627
29.2 Hydrocephalus .....	627
Causes of hydrocephalus.....	628
29.2.1 Obstructive hydrocephalus .....	628
29.2.2 Aresorptive hydrocephalus.....	629
29.2.3 Hypersecretory hydrocephalus.....	629
Diagnosis.....	629
Clinical presentation .....	630
Treatment.....	631
29.2.4 “Normal pressure” hydrocephalus .....	631
Diagnosis.....	631
Differential diagnosis.....	632
Treatment .....	632
29.3 Chiari Malformation.....	632
29.3.1 Causes of Chiari I malformation.....	633
29.3.2 Clinical presentation .....	633
29.3.3 Diagnosis.....	633
29.3.4 Treatment of Chiari I malformation .....	634
29.4 Syringomyelia .....	634
29.4.1 Post-traumatic syringomyelia .....	634
29.4.2 Peritumoral syringomyelia.....	634
29.4.3 Syringomyelia associated with hydrocephalus .....	635
29.4.4 Syringomyelia associated with Chiari malformation.....	635
29.4.5 Idiopathic syringomyelia .....	635
Bibliography .....	636
<b>30 BRAIN DEATH</b>	<b>637</b>
Oriano Mecarelli, Patrizia Pulitano, Edoardo Vicenzini	
30.1 Clinical diagnosis .....	638
30.2 Instrumental examinations and legislative-procedural tools .....	639
30.3 Conclusion .....	641
Bibliography .....	641
<b>31 NEUROREHABILITATION</b>	<b>643</b>
Michelangelo Bartolo, Mariano Serrao, Stefano Filippo Castiglia, Francesco Pierelli	
31.1 Rehabilitation team .....	643
31.2 Rehabilitation plan.....	644
31.3 Rehabilitation program .....	644
31.4 Assessment scales and scores .....	644
31.5 Neurorehabilitation methods.....	644
31.5.1 Vojta method.....	645
31.5.2 Kabat method (proprioceptive neuromuscular facilitation, PNF) .....	646
31.5.3 Bobath method .....	646
31.5.4 Perfetti method (cognitive therapeutic exercise, action comparison, or neurocognitive rehabilitation).....	646
31.5.5 Grimaldi method .....	647

31.5.6 Hydrokinesitherapy.....	647
31.5.7 Action observation therapy.....	647
31.6 Main pathologies undergoing neurorehabilitation .....	647
31.6.1 Stroke .....	647
Organizational models for stroke management .....	649
31.6.2 Parkinson's disease .....	649
Rehabilitation strategies .....	650
Treatment of musculoskeletal consequences .....	650
Promotion of physical activity and fall prevention.....	650
31.6.3 Multiple sclerosis .....	651
Balance and coordination.....	653
Gait disorders.....	653
Spasticity.....	654
Urinary disorders.....	654
31.6.4 Amyotrophic lateral sclerosis .....	654
Upper limbs .....	655
Lower limbs .....	655
Respiratory dysfunction .....	656
Language and communication .....	656
Swallowing and nutrition.....	657
31.6.5 Ataxia .....	657
31.6.6 Severe acquired brain injuries: traumatic brain injury.....	658
Acute phase.....	658
Post-acute phase .....	658
Outcome management phase .....	659
Cognitive rehabilitation.....	659
Assistive memory devices .....	659
31.6.7 Spinal cord injuries .....	659
Activities of daily living (ADL) .....	661
31.6.8 Peripheral nervous system injuries .....	661
31.7 New frontiers in neurorehabilitation .....	662
31.7.1 Quantitative movement analysis.....	662
31.7.2 Robotic rehabilitation.....	664
Upper extremity robots.....	664
Lower extremity robots.....	664
31.7.3 Virtual reality.....	665
31.7.4 Tele-rehabilitation .....	665
Bibliography .....	665

## 32 PEDIATRIC NEUROLOGY

667

Francesca Nardeccchia, Serena Galosi, Mario Mastrangelo, Francesco Pisani, Vincenzo Leuzzi

32.1 Neurodevelopmental disorders .....	668
32.2 Dementia and mental deterioration.....	671
32.3 Movement disorders in early childhood .....	674
32.3.1 Cerebral palsy (CP).....	677
32.3.2 Other movement disorders in children.....	678
32.3.3 Hereditary spastic paraparesis .....	681
32.3.4 Ataxias .....	683
32.4 Epilepsy and epileptic syndromes.....	688
32.4.1 Epileptic and developmental encephalopathies (DEE) .....	693
32.4.2 Most common epileptic syndromes in pediatric age .....	693

32.4.3	Febrile seizures .....	694
32.4.4	Genetic-metabolic epilepsies .....	695
32.4.5	Epilepsies related to pyridoxine metabolism dysfunctions .....	697
32.4.6	Epilepsy due to glucose transporter deficiency (GLUT1 deficiency) .....	697
32.4.7	Epilepsy due to biotin metabolism disorders .....	698
32.4.8	Serine metabolism deficiency .....	698
32.4.9	Status epilepticus .....	698
32.5	Hypotonia and neuroperipheral pathology .....	699
32.6	Isolated cranial nerve deficits in children .....	701
	Bibliography .....	702

### 33 PSYCHIATRIC PRINCIPLES

703

Isabella Berardelli, Massimo Pasquini, Massimo Biondi

33.1	Psychopathological evaluation .....	704
33.2	Psychiatric disorders in neurological diseases.....	707
33.2.1	Mood disorders.....	707
	Depression .....	707
	Bipolar disorder .....	709
33.2.2	Anxiety disorders .....	710
	Panic disorder and agoraphobia .....	710
	Phobic disorders .....	711
	Generalized anxiety disorder .....	711
33.2.3	Trauma and stressor-related disorders .....	711
33.2.4	Obsessive-compulsive disorder and its correlates .....	712
	Body dysmorphic disorder .....	714
33.2.5	Schizophrenia.....	714
	Schizoaffective disorder .....	715
	Delusional disorder .....	716
33.2.6	Somatic symptoms and related disorders .....	716
	Somatic symptom disorder .....	717
	Conversion disorder .....	717
33.2.7	Dissociative disorders .....	717
	Dissociative fugue .....	718
	Depersonalization/derealization disorder .....	718
	Dissociative identity disorder .....	718
33.2.8	Eating disorders .....	719
	Anorexia nervosa .....	719
	Bulimia nervosa .....	719
33.2.9	Personality disorders .....	719
	Treatment of personality disorders .....	723
33.3	Therapeutic opportunities .....	723
33.3.1	Psychopharmacotherapy.....	723
33.3.2	Psychotherapy .....	726
	Psychoanalysis .....	726
	Behavioral therapy .....	727
	Cognitive psychotherapy .....	728
	Systemic-relational therapy .....	728
33.3.3	Physical therapies .....	729
33.3.4	Treatment of major psychiatric disorders .....	729
	Treatment of depressive disorder .....	729
	Treatment of bipolar disorder .....	730

---

Treatment of anxiety disorders .....	730
Treatment of obsessive-compulsive disorder .....	730
Treatment of schizophrenia.....	730
Compulsory hospital admissionr .....	730
Emergencies and suicide risk in psychiatry .....	731
Bibliography .....	732