# Index

A	neuromuscular synapse, tyrosine	Action potentials
ABCA1 ATP-dependent transporter	phosphorylation, 509, 510	depolarization propagation, 67
cholesterol and phospholipid translocation,	nicotinic acetylcholine receptors, 266–274	electrically excitable cells, 66-67
51–52	agonist binding, 268–269	ion channels, 66
cholesterol synthesis, 31-32, 32f	agonist desensitization, 269, 270f	odorant recognition, 907-908, 908f
Acetylation, polyglutamine repeat	biochemical characterization, 266-267,	Acute axonal motor neuropathy, 698-699,
diseases, 850	267f	698f
Acetylcholine	brain function modulation, neuronal	Acute disseminated encephalomyelitis
acetylcholinesterase	receptor, 271	(ADEM), 697
acetylcholine removal, 262	cys-loop ligand-gated ion channel family,	Acute post-infectious measles
active site, 264–265	268f, 269	encephalomyelitis (APME),
catalysis, 263–264, 264f	disease and, 272–273	immune functions and, 607
gene encoding, 263	ion channel communication, 269	Adaptive immunity
Gulf War syndrome, inhibition, 279–280,	neuronal receptor family, 269-270, 270f	evolutionarily novel molecules, 599
280f	non-neuronal distribution, 272	nervous system regulation, 602-603
inhibitors, 265–266, 266f	pentameric ligand-gated ion channels,	neuroimmunology, 599-601
molecular forms, 262-263, 263f, 265f	267–268, 268f	lymphoid tissue innervation,
nonclassical functions, 266	subunit permutations and diversity, 270f,	602–603
in basal ganglia, 858	271	neuropeptides, 603
brain energy metabolism, acetyl coenzyme	therapeutic targeting, 273–274	Addiction
precursor, 218–219	transgenic research, physiology and	barbiturates and benzodiazepines, 1050
chemical structure, 259–260, 259f	clinical implications, 271–272	basic principles, 1038, 1039f
cholinergic pathways	organophosphorus poisoning signs and	cannabinoids, 1045-1048, 1047f
choline acetyltransferase catalyst, 260	symptoms, 279t	cyclic AMP second-messenger pathway,
neuron distribution, central nervous	presynaptic release, botulinium toxin	1042–1043
system, 262, 262f	alteration, 795–796	dopamine transmission, 1038-1040, 1040f,
synaptic terminal, choline accumulation,	receptor mutations, 789	1042f
260–261, 261f	myasthenia gravis, 793, 794f	ethanol, 1049
vesicular transporters, calcium-	sleep and wakefulness and, 987-988	hallucinogens and dissociative drugs,
dependent neuronal release,	depression, REM sleep and pain, 988	1050–1051
261–262, 262f	synthesis, storage and release, 260-262	neural circuitry, 1038–1041
choline transporter termination in	Acetylcholinesterase	neuronal plasticity, 1051–1052, 1052f
synapse, 54	acetylcholine breakdown, 262–266	nicotine, 1048–1049
enzymatic breakdown, 262–266	acetylcholine removal, 262	opiates, 1041–1043
muscarinic cholinergic receptors, 274–280	active site, 264–265	psychomotor stimulants, 1043-1045, 1044f,
G-protein-coupled receptor mediation, 274	catalysis, 263–264, 264f	1046f
molecular cloning, 275–276, 275f	gene encoding, 263	Adenosine
muscarine mimicking, 274	inhibitors, 265–266, 266f	extracellular sources, 379–380
neuropsychiatric disorders, central	molecular forms, 262-263, 263f, 265f	metabolites, 380f
nervous system distribution, 277	nonclassical functions, 266	opioid-induced sleep disruption and pain,
peripheral tissue physiology, 274t	deficiency, 790	993–994
pharmacological therapies, cholinergic	Gulf War syndrome, inhibition, 279–280,	receptor subtypes, 382, 382t
disorder, 278	280f	$A_1$ receptors, 383, 383f
subtype distribution, 277	protein active site, 264–265, 264f	A <sub>2A</sub> receptors, 383, 383f
subtype-G-protein coupling, 276, 276f	Acid maltase deficiency (AMD), 766–767,	Parkinson's disease and antagonists of
subtypes, pharmacological analysis,	770	387–388
274–275	Acquired immune-mediated myelin disease,	$A_{2B}$ receptors, 384
synaptic terminal, choline accumulation,	692–699	A <sub>3</sub> receptors, 384
260–261, 261f	axonal effects, 692	P <sub>2</sub> receptors, 384
transgenic studies, in vivo subtype	diagnosis, 692–693	sleep regulation, 993–994
assessment, 277–278	multiple sclerosis, 692–696	transport, 379–380, 380f
neuromuscular junction disorders, 789-790	Actin microfilaments	wakefulness and, 993
neuromuscular junction mediation, release	hair cell molecules, 921–923	Adenosine epilepsy hypothesis, 387
and postsynaptic effects, 238-239,	neuronal growth and secretion,	Adenosine kinase, nervous system disorders
240–241f, 785	108–110	387

Adenosine triphosphate (ATP) axonal release, 385	binding, 268–269 desensitization, 269, 270f	GABA disorders, 752–753 glutathione metabolic disorders, 752, 753f
brain energy metabolism	glutamate receptors, 354, 355f	homocystinuria, 745–749, 746f
electron transport chain production, 217	nicotinic acetylcholine receptors, nicotine	major metabolic pathways, 740f
glycolysis, 208–209	addiction, 1048	methionine synthase deficiency, 748
phosphocreatine regulation, 218	Agrin receptor, neuromuscular synapse,	N-acetylaspartate disorders, 753
regulation, 217–218	tyrosine phosphorylation, 509	nonketotic hyperglycinemia, 744–745, 745f
glial signaling, adenosine and, 384–385	Agrochemicals, acetylcholinesterase	phenylketonuria, 743–744, 743f
synaptic transmission, regulated secretory	inhibitors, 265–266, 266f	urea cycle defects, 749–752, 749f
pathway, 245	Alcohol addiction, 1049–1050	cognition and, 752
Adenylosuccinate lyase, Lesch-Nyhan	novel treatments for, 1053	Amino acid precursors, brain energy
syndrome, 381	Alcohol effects, extracellular adenosine, 387	metabolism, glycolysis regulation,
Adenylyl cyclases	Allele-specific gene silencing, polyglutamine	208–209
cAMP biochemistry, 423–425, 424f	repeat diseases, 851–853	Amino acids
cAMP molecular targets, 429–430	Allodynia, pain management, 936–937	glutamate derivation, 343–344, 344f
brain signaling functions, 430	Allostasis, stress and, 951	glycine receptor activation, 250
cyclic nucleotide-gated channels, 429	Allostatic overload, stress and, 951	L-tryptophan, serotonin precursor, 304–306
dopamine signaling, striatum, 430	Alsin mutation, amyotrophic lateral sclerosis,	sleep regulation and, 990-993
drug abuse, 430	803	Amino acid sequencing
Epac, 430	Alzheimer's disease	histamine receptors, 332f
neurodegeneration, 430	amyloid beta immunotherapy, 616	odorant receptors, 905–906, 906f
olfaction, 430	APP mutations, 817	Amino acid transmitters
pain management, 430	aspartyl proteases, 819–820	glutamate-glutamine metabolism, 220
protein kinase A, 429	clinical syndrome, 816	glutamate symporters, SLC1 proteins, 53
synaptic plasticity, learning and memory,	cytoskeleton alterations and, 114	SLC6 symporter subfamily, 52–53
430	epidemiology, 815–823	Aminoaciduria disorders, 738–742, 739t, 741t
cellular regulation models, 427–429, 428f	familial forms, 817	brain edema, 742
G protein stimulation and inhibition, 412	gamma-secretase and presenilins, 824–825	brain energy metabolism inhibition,
isozyme expression and regulation,	gene targeting therapy, 821–822	738–740
425–427	genetics, 721–723, 721t	low-protein diet, 742
long-term regulation, 429	early onset familial AD, 721	neurotransmitter/neurotransmitter
phylogenetic tree, 425f	late-onset AD	receptor deficits, 742
serotonin receptor subtype stimulation, 319–320	apolipoprotein E in, 721–722	organic acid conversion, 738  Ammonia detoxification, urea cycle and,
topographical structures, 425f	genome-wide screening, 722–723 laboratory measurements and diagnosis,	749–750
Adipose triglyceride lipase (ATGL) defects,	816	cognitive function and, 752
768	neuritic plaques, 818	Ammonia nitrogen excretion, urea cycle
ADP-ribosylation, G protein modification,	neurofibrillary tangles, 818–819	defects, 751
419–420	neurotransmitter circuits and brain	Amnesia patients, memory function studies,
Adrenal gland, stress and brain function and,	networks and, 817–818	964–965
946	presenliin 1 and 2 mutations, 817	Amphetamine addiction, 1043-1044, 1044f
Adrenal medulla, norepinephrine	protein phosphorylation and, 490–491	neuronal adaptation, 1044
metabolism to epinephrine, 288	transgenic mouse models, 820–823	Amphipathic molecules
Adrenergic neurons, dopamine-	Amiloride, FMRF-amide-gated sodium ion	bilayered lamellar structures, 27-28, 28f
norepinephrine conversion, 286	channel, peptide expression, 402	multidrug resistance protein flipping, 52
Adrenergic receptors, 295–297, 295t, 296t	α-Amino-3-hydroxy-5-methyl-4-isoxazole	Amphiphilic molecules, membrane lipids
G-protein-coupled receptors, 295–297	propionic acid (AMPA) receptor	as, 82
Adrenocorticotropic hormone (ACTH),	flip/flop variants, 354–356, 355f	Amygdala, stress and, 949–951
neuronal synthesis, 393–394	identification, 347–356	Amyloid beta immunotherapy,
Adrenoleukodystrophy, myelination and, 578	long-term potentiation induction, 967f	neuroinflammation, 616
Afferent sensory neurons, taste, 912	quinoxalinedione blockage, 350	Amyloid beta peptides
Age-related macular degeneration, 899	Amino acid metabolism disorders	Alzheimer's disease pathology and, 818
Aging	aminoaciduria, 738–742, 739t, 741t	transgenic mouse models, 820–821
Alzheimer's disease epidemiology and,	brain edema, 742	seeding and transmissibility, 883–884
815–823	brain energy metabolism inhibition,	Amyloid precursor protein (APP)
brain energy metabolism, cerebral	738–740	Alzheimer's disease
metabolic rate declines, 205	low-protein diet, 742	aspartyl protease cleavage, 819–820
microglial dysfunction in, 613	neurotransmitter/neurotransmitter	secretase cleavages, 818
sodium-potassium- adenosinetriphosphatase and, 45	receptor deficits, 742 organic acid conversion, 738	familial Alzheimer's disease, mutations, 817
Agonists	blood amino acid imbalance, 740–742	Amyotrophic lateral sclerosis (ALS)
catecholamines, downregulation, 297	brain amino acids, lipid synthesis	epidemiology, 801–806
cholinergic	inhibition and demyelination, 742	familial, 803–806
chemical structure, 259–260, 259f	branched-chain amino acids, maple syrup	genetics, 727–729, 728t
nicotinic acetylcholine receptors	urine disease, 742–743	familial ALS, 727–729

1.1 (.00/.000		1 1 1 1 1 1 7
models of, 806–809	Antiseizure drugs, epilepsy and mechanisms	cyclooxygenase-derived metabolites, 652
mutations, 803–806	of, 711–713	cyclooxygenase/lipoxygenase conversion,
pathophysiology, 802	GABA-mediated synaptic inhibition,	648–649, 648f, 649f
	, <u>,</u>	
SOD1 mice studies, 807	711–712, 712f	ischemia-reperfusion process, 656
Anaplerotic pathway, brain energy	voltage-gated calcium currents, 712, 712f	lipoxygenase substrate, 649
metabolism, pyruvate	voltage-gated sodium channel targeting,	5-HpEtE formation, 653
carboxylation, 218	711, 711f	molecular oxygen requirements, 649
	· · · · · · · · · · · · · · · · · · ·	
Andersen's disease, 767	Antisense oligonucleotides, polyglutamine	neuroinflammation, 614–615, 615f
Anderson syndrome, potassium ion channel	repeat diseases, 850–851	phospholipases A <sub>2</sub> , ischemia and seizures,
mutation, 791	Anxiety disorders	647
Angiogenic factors, amyotrophic lateral	cholecystokinin, 1032–1033	Arginase deficiency, 751
		•
sclerosis, 803–804	cortical-hypothalamic-pituitary-adrenal	Argininosuccinic aciduria, 751
Animal models	axis, 1032	Aromatic amino acid decarboxylase (AAAD)
Huntington's disease, 865	epidemiology, 1030	L-DOPA-dopamine conversion, 285–286
mechanoreceptors, 917–918, 917f	future research and therapies, 1033–1034	serotonin precursor, 306
Parkinson's disease, 862, 863f	GABAergic systems, 1031–1032	ARX gene mutation, epilepsy genetics, 714
sleep disorders, 989–990	intracellular targeting, 1033	Aspartate, neurotransmission and, 346
synucleinopathies, 833-834	neurochemistry, 1030-1033	Aspartyl proteases, amyloid precursor
tauopathies, 838–841, 838f, 839f	neuropeptides, 1032–1033	
-		protein cleavages, Alzheimer's
Animal prion diseases, 873–874	neuropeptide Y, 1032	disease, 819–820
Anion antiporters, 56	noradrenergic systems, 1030–1031	Astrocyte-lactate shuttle, brain energy
intracellular pH in brain, 56	serotonergic systems, 1031	metabolism, 215
<u> </u>		
Antagonists	substance P, 1033	Astrocytes
catecholamines, repeated treatment,	Apolipoprotein E (APOE), Alzheimer's	adenosine-dependent heterosynaptic
297–298	disease, 721–722	depression, 385
cholinergic	Apoprotein E (apoE), astrocyte secretion,	aquaporin4 in membranes of, 57–58, 58f
ĕ		
chemical structure, 259–260, 259f	31–32, 32f	blood-brain barrier maintenance, 19
nicotinic acetylcholine receptors	Apoptosis	brain energy metabolism
binding, 268–269	axon-based nervous system development,	citrate synthesis and release, 218
desensitization, 269, 270f	542–543	enzymes in, 207t
protein phosphorylation, kinase/	basic features, 665f	glutamate-glutamine cycle, 222
phosphatase antagonism,	cascade triggering, 672, 673f, 674f	glycogen degradation, 209–210
468-470	caspase substrates, 664t	pyruvate carboxylation, 218
purinergic receptors, A <sub>2A</sub> receptors and	cell morphology and biochemistry, 664	subcellular compartmentation, 225–226
Parkinson's disease, 387–388	embryonic and postnatal development,	calcium signaling, local and global
Anterograde axonal transport	663–664	integration, 461–464, 463f
fast transport	ischemia-reperfusion injury, reactive	cerebral vasculature control, 463–464,
membrane and secretory proteins, 150f,	oxygen species, 631	463f
151f, 152f	nervous system development, 664–665	tripartite synapse, gliotransmitter and
synaptic vesicles, axolemmal precursors	neurodegenerative disorders, 667–668, 667f	modulation, 462–463
and mitochondria, 153	neurological disease and, 665-667, 673-675	cholesterol synthesis, 31–33, 33f
kinesin, 157–158	phosphoinositides, 452	glutamine transfer to neurons, 362
membrane and secretory proteins, 151–152	phospholipases A2, ischemia-reperfusion	pH-dependent purine release, breathing
Antiapoptotic proteins, 671	signaling, 654	control, 386
Antibody-mediated neuropathies, 684–687,	synaptic plasticity, 675	synaptic transmission, signaling events,
686t	triggers for, 668–669	256
Antidepressants, cyclic nucleotide signaling	trophic insufficiency, 668	Astrocytic interphase, 11, 11f, 12f
and, 437–438	Appetite regulation, neuropeptides, 405	Astrocytic perivascular endfleet membranes,
Antigenic stem cells, 561–563	Aquaporins	aquaporins, 57
Antigen-presenting cells (APCs)	AQP4 regulation, serine phosphorylation,	Astroglia, neuronal extracellular clearance of
0 1	9	9
innate immunity, 601, 601f	58	potassium and water, 58
major histocompatibility complex, T-cell	in astrocyte membranes, 57–58, 58f	Ataxin proteins, polyglutamine repeat
activation, neuroimmunology,	astrocytic perivascular endfleet	diseases, 849
599–601, 600f	membranes, 57	SCA-7 transcription, 849
		-
microglia and, 605–606	in brain, 57	ATP-binding cassette transporters (ABC)
neuropeptide modulation, 603	brain edema	blood-brain barrier luminal membranes,
PAMP and DAMP signals, 602	aquaporin-4 regulation, 59–60	22–23
Antioxidants	ischemia and, 632	gene superfamilies, 50
apoptosis inhibition, 671–672	facilitated diffusion, 56–58	prokaryotic three-dimensional structures,
ischemia-reperfusion injury, brain	myelin disease, 693	50–51, 51f
protection, 630–631	Arachidonic acid pathways	Autism spectrum disorders (ASDs)
tripeptide glutathione, 752	brain injury, lipid breakdown, 654–655	behavioral, neurobiological and genetic
	7 2 2	9 9
Antipsychotic drugs	brain signaling mechanisms and, 658–660	issues, 1013
addiction, 1050	cyclooxygenase conversion, prostaglandin	clinical aspects, 1012–1014
schizophrenia, 1001–1002	H <sub>2</sub> , 652	current research issues, 1013–1014

Autism spectrum disorders (ASDs) (Continued)	kinesins, 157–159	Basement membrane (BM), blood-brain
dopaminergic functioning, 1015	membrane-bound organelles, 158	barrier and, 19–21
epistasis and emergenesis, 1014	myosins, 160	Bcl-2 protein, mood disorders and, 1029
fragile X syndrome and, 1017–1018	myelination regulation, 574	Behavioral arousal/activity
future research issues, 1016–1017	neural organelle motion, 147, 147f	autism spectrum disorders, 1013
genetic studies, 1014	neuronal size and extent, 147–148	immune-related changes in neuronal
melatonin decrease, 1016	neuropathology and, 161	function and, 607–608
neurochemistry, 1014-1016	rate components, 148t, 149f	olfaction and, 909–910
pharmacological treatment, 1014	slow transport	serotonin, 311–312
postmortem brain data, 1014	cytoplasmic/cytoskeletal elemnts, 155	stress and, 950-951
serotonin system, 1015–1016	growth and regeneration rates, 155-156	Benzodiazepine addiction, 1050
stress response systems, 1015	molecular mechanisms, 156	Beta-enolase deficiency, 766
symptom clusters, 1012–1013	Axonal Transport, neuropathology and, 161	Beta-sheet conformation, prion protein,
Autocrine effects, neuropeptide receptors, 402	Axons, 4–6, 5f	879–880, 879f
Autoimmune disease	adenosine triphosphate release, 385	Bioactive lipid mediators, phospholipid
nicotinic acetylcholine receptors, 272	brain energy metabolism assays, 226	reservoirs, 645
peripheral neuropathies, 684–687	compartmental elements, 9–10, 9f	Bioactive peptide products, tissue-specific
Autophagy	cytoskeleton and organization of, 102, 102f,	processing, 394, 395f
endocytic pathway, macromolecular	104f	Biogenesis, peroxisomal diseases, 761, 762t
degradation and nutrient uptake,	early differentiation, 111–112	Biogenic amines, SLC6 symporter subfamily,
135–137	glia influence on, 112–114, 113f	52–53
polyglutamine protein turnover, 846–849	epilepsy, sprouting, dentate granule	Biological membranes, basic properties, 29–36
Autosomal dominant Parkinson's disease,	circuits, 709	Biopterin, phenylketonuria and deficiency
genetics, 723	growth and regeneration, slow axonal	in, 744
Autosomal recessive Parkinson's disease,	transport, 155–156	Biosynthetic secretory pathway
genetics, 723–724	myelin in, 185	catecholamines, 284f
Axolemma	repair mechanisms, 702–703	intracellular membrane trafficking, 120,
ion channels, voltage-dependent gating	myelin sheath and function of, 578	126–135
mechanisms, 66, 67f	nervous system development, 542–543	compartments and transport sequence,
precursors, anterograde fast axonal	neurofilament disruption, neuropathology	128f
transport, 153	and, 115–116	constitutive secretory pathway, 133f, 134
Axonal growth	peripheral neuropathies, degeneration and	COPII-coated vesicles, Golgi complex
axotomy, structural and biochemical	protection, 687–688	delivery, 127–129
	Axotomy, structural and biochemical changes	
changes, 585		endoplasmic reticulum classification, 126–127
cell adhesion molecules, 585	and, 585	126–127
cell adhesion molecules, 585 glial scar and, 589–590	and, 585	126–127 glycosylation compartmentalization, 127t
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN	and, 585 <b>B</b>	126–127 glycosylation compartmentalization, 127t Golgi apparatus components, 129
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806	and, 585  B Bacterial toxins, G protein modification,	126–127 glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport,
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition,	and, 585  B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420	126–127 glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586	and, 585  B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917	126–127 glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration,	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways,
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t,	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153 biochemistry and pharmacology, 151	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868 Parkinson's disease, 861–865, 863f	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream signaling, 897
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153 biochemistry and pharmacology, 151 Golgi apparatus passage, 152–153, 153f	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868 Parkinson's disease, 861–865, 863f movement control and, 857	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream signaling, 897 Blood-brain barrier (BBB)
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153 biochemistry and pharmacology, 151 Golgi apparatus passage, 152–153, 153f membrane and secretory proteins, 150f,	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868 Parkinson's disease, 861–865, 863f movement control and, 857 neurotransmitter systems in, 857–860	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream signaling, 897 Blood-brain barrier (BBB) astrocytes and maintenance of, 19
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153 biochemistry and pharmacology, 151 Golgi apparatus passage, 152–153, 153f membrane and secretory proteins, 150f, 151–152, 151f, 152f	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868 Parkinson's disease, 861–865, 863f movement control and, 857 neurotransmitter systems in, 857–860 acetylcholine, 858	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream signaling, 897 Blood-brain barrier (BBB) astrocytes and maintenance of, 19 ATP-binding cassette transporters,
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153 biochemistry and pharmacology, 151 Golgi apparatus passage, 152–153, 153f membrane and secretory proteins, 150f, 151–152, 151f, 152f molecular sorting mechanisms, 154–155	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868 Parkinson's disease, 861–865, 863f movement control and, 857 neurotransmitter systems in, 857–860 acetylcholine, 858 dopamine, 859–860, 859f	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream signaling, 897 Blood-brain barrier (BBB) astrocytes and maintenance of, 19 ATP-binding cassette transporters, molecular entry restriction, 22–23
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153 biochemistry and pharmacology, 151 Golgi apparatus passage, 152–153, 153f membrane and secretory proteins, 150f, 151–152, 151f, 152f molecular sorting mechanisms, 154–155 retrograde transport, 153–154	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868 Parkinson's disease, 861–865, 863f movement control and, 857 neurotransmitter systems in, 857–860 acetylcholine, 858 dopamine, 859–860, 859f dopamine-acetylcholine balance, 860	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream signaling, 897 Blood-brain barrier (BBB) astrocytes and maintenance of, 19 ATP-binding cassette transporters, molecular entry restriction, 22–23 basal lamina and basement membrane,
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153 biochemistry and pharmacology, 151 Golgi apparatus passage, 152–153, 153f membrane and secretory proteins, 150f, 151–152, 151f, 152f molecular sorting mechanisms, 154–155 retrograde transport, 153–154 hereditary spastic paraplegias, deficits and	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868 Parkinson's disease, 861–865, 863f movement control and, 857 neurotransmitter systems in, 857–860 acetylcholine, 858 dopamine, 859–860, 859f dopamine-acetylcholine balance, 860 GABA, 857, 858f	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream signaling, 897 Blood-brain barrier (BBB) astrocytes and maintenance of, 19 ATP-binding cassette transporters, molecular entry restriction, 22–23 basal lamina and basement membrane, 19–21
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153 biochemistry and pharmacology, 151 Golgi apparatus passage, 152–153, 153f membrane and secretory proteins, 150f, 151–152, 151f, 152f molecular sorting mechanisms, 154–155 retrograde transport, 153–154 hereditary spastic paraplegias, deficits and pathogenic mechanisms, 146	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868 Parkinson's disease, 861–865, 863f movement control and, 857 neurotransmitter systems in, 857–860 acetylcholine, 858 dopamine, 859–860, 859f dopamine-acetylcholine balance, 860 GABA, 857, 858f glutamate, 858	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream signaling, 897 Blood-brain barrier (BBB) astrocytes and maintenance of, 19 ATP-binding cassette transporters, molecular entry restriction, 22–23 basal lamina and basement membrane, 19–21 brain energy metabolism
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153 biochemistry and pharmacology, 151 Golgi apparatus passage, 152–153, 153f membrane and secretory proteins, 150f, 151–152, 151f, 152f molecular sorting mechanisms, 154–155 retrograde transport, 153–154 hereditary spastic paraplegias, deficits and pathogenic mechanisms, 146 molecular motors, 156–161	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868 Parkinson's disease, 861–865, 863f movement control and, 857 neurotransmitter systems in, 857–860 acetylcholine, 858 dopamine, 859–860, 859f dopamine-acetylcholine balance, 860 GABA, 857, 858f glutamate, 858 multiple systems, 860	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream signaling, 897 Blood-brain barrier (BBB) astrocytes and maintenance of, 19 ATP-binding cassette transporters, molecular entry restriction, 22–23 basal lamina and basement membrane, 19–21 brain energy metabolism endothelial cell transporters, glucose/
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153 biochemistry and pharmacology, 151 Golgi apparatus passage, 152–153, 153f membrane and secretory proteins, 150f, 151–152, 151f, 152f molecular sorting mechanisms, 154–155 retrograde transport, 153–154 hereditary spastic paraplegias, deficits and pathogenic mechanisms, 146 molecular motors, 156–161 biochemical properties, 157	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868 Parkinson's disease, 861–865, 863f movement control and, 857 neurotransmitter systems in, 857–860 acetylcholine, 858 dopamine, 859–860, 859f dopamine-acetylcholine balance, 860 GABA, 857, 858f glutamate, 858 multiple systems, 860 Basal lamina	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream signaling, 897 Blood-brain barrier (BBB) astrocytes and maintenance of, 19 ATP-binding cassette transporters, molecular entry restriction, 22–23 basal lamina and basement membrane, 19–21 brain energy metabolism endothelial cell transporters, glucose/ monocarboxylic acid uptake,
cell adhesion molecules, 585 glial scar and, 589–590 neurofilamentous axonal pathology, IDPN administration, 806 Nogo-A protein, neurite growth inhibition, 586 peripheral nervous system regeneration, 583–585 Schwann cells and basal lamina requirements, 584 Wallerian degeneration, peripheral nervous system, 583 Wallerian degeneration and myelin sheath disruption, 583, 584f, 584t Axonal transport fast and slow components, 148–150, 148t, 149f molecular mechanisms, 156 fast transport anterograde transport, 153 biochemistry and pharmacology, 151 Golgi apparatus passage, 152–153, 153f membrane and secretory proteins, 150f, 151–152, 151f, 152f molecular sorting mechanisms, 154–155 retrograde transport, 153–154 hereditary spastic paraplegias, deficits and pathogenic mechanisms, 146 molecular motors, 156–161	B Bacterial toxins, G protein modification, ADP-ribosylation, 419–420 Balance, mechanotransduction, 916–917 vestibular organs, 923–926 Barbiturate addiction, 1050 Bardet-Biedl Syndrome, 23 Bariatric surgery, peripheral neuropathies and, 687 Basal ganglia A <sub>2A</sub> receptors in, 383, 383f anatomy and physiology, 856–861 disorders of, 861–868 connectivity losses, 869–870 drug actions, 868 dystonia, 866–867 Huntington's disease, 865–866, 866f neuropsychiatric disorders, 867–868 Parkinson's disease, 861–865, 863f movement control and, 857 neurotransmitter systems in, 857–860 acetylcholine, 858 dopamine, 859–860, 859f dopamine-acetylcholine balance, 860 GABA, 857, 858f glutamate, 858 multiple systems, 860	glycosylation compartmentalization, 127t Golgi apparatus components, 129 Golgi cisternae protein/lipid transport, cis to Trans direction, 130–131, 131f lysosomal pathway convergence, 132 neuroendocrine secretion pathways, 132–133 protein sorting and glycosylation, Golgi complex, 129–130 secretory cells, regulated pathway specialization, 133f, 134 secretory vesicle biogenesis, 134–135 trans-Golgi network, lysosomal protein sorting and targeting, 132 trans-Golgi network, plasma membrane protein sorting, 131–132 neuropeptides, 394, 394f, 395f Biotin-dependent syndromes, 772 Bipolar cells, photoreceptor downstream signaling, 897 Blood-brain barrier (BBB) astrocytes and maintenance of, 19 ATP-binding cassette transporters, molecular entry restriction, 22–23 basal lamina and basement membrane, 19–21 brain energy metabolism endothelial cell transporters, glucose/

neuropathology and alteration of, 204 Brain function SLC25A12 gene mutation, brain function and, 17-18, 18t aminoaciduria disorders, 738-740 N-acetylaspartate formation and central nervous system, 16-18, 17f blood-brain barrier and blood-cerebral myelination, 212-213, 212f diseases and therapeutic efficacy, 23 spinal fluid barrier and, 17-18 sleep regulation, 983-984, 984f cholesterol transport and regulation, 31 carbohydrate/lipid metabolic disorders, stress and, 945-946, 947f CNS immune activity and, 604 770-772 allostasis and allostatic overload, 951 evolution of concept, 18 cGMP signaling, guanylyl cyclase behavioral effects, 950-951 receptors, 433–434 extracellular fluid control, 18 future research issues, 953-954 hippocampus, 946-947 facilitated glucose diffusion, 58-59 cholesterol synthesis, adult astrocytes, glutamate transport, 343-344 31-32 modern life factors, 951-953 lipid solubility and substance permeability continuous cerebral circulation, 206 neurogenesis and, 959–960 through, 21-22 energy metabolism prefrontal cortex and amygdala, 949-951 multiple transporters and transport aging and maturation declines, 205 research and definitions, 946-947 processes, 21-23, 21t basic requirements, 202t sleep and circadian rhythms and blood-brain barrier transport, 204 pathogenesis and dysfunction of, 23 stress axis, 946 pericytes, 19 brain imaging and spectroscopy, stress hormones, 946 protein, metabolite and toxin exchange, 222-226, 223f, 224f, 225f Brain growth factors, mood disorders, 1025 18-21, 18t cell and subcellular structures and Brain imaging solute carriers, 22 functions, 203 function-derived signals, 202-203 transport function, 19, 20f compartmentalization, 207 glycine receptor distribution, 252 schizophrenia, 1003-1004 Blood-cerebral spinal fluid barrier compound concentrations, intact brain, brain function and, 17-18, 18t Brain injury. See also Ischemia central nervous system, 16-18, 17f developmental metabolic rate, 205 acute ischemic stroke, potential therapeutic Blood composition, amino acid imbalance, developmental transporters and strategies, 638-640 neurotransmitters and protein pathways, 204-205 compensatory plasticity and functional glutamate-glutamine metabolism, recovery, Nogo-A blockade, synthesis effects, 740-742 Blood oxygen level-dependent (BOLD) signal 220-222, 221f 591-592, 591f brain energy metabolism, 223 glycogen synthesis, astrocytic ischemic phase, 627-629 brain function and, 206 degradation, 209-210 calcium overload, 627-628, 628f Botulinium toxin, muscle excitation glycolysis, 207-209, 208f excitotoxicity, 627 alteration, 795-796 imaging applications, signaling NMDA receptors mechanisms, 202-203 Bovine spongiform encephalopathies, prion brain function and cell death, 628-629 protein dysfunction, 873-874 lactate metabolism, 211-215 downstream cell death signals, 629, Brain chemistry, amino acid disorders, lowmalate-aspartate shuttle, 210-211, 214f protein diet, 742 mitochondrial heterogeneity, 219-220 membrane lipid breakdown, 654-655 Brain-derived neurotrophic factor (BDNF) neuropathology, 226 neonatal brain damage, compensatory basic properties, 548-550 pentosphosphate shunt, 210 plasticity and, 590 epileptogenesis, 710-711 signaling mechanisms, 201-202 neuroprotection signaling and mood disorders and, 1029 SLC25A12 gene mutation, inflammation resolution, 632-638 Brain development N-acetylaspartate formation and apoptotic signaling, 633-635, 634f, 635f aquaporins in, 57 myelination, 212-213, 212f docosanoids and penumbra protection, brain energy metabolism sleep regulation, 983f 635-638, 636f, 637f cerebral metabolic rate, 205 substrates, 203-204 inflammatory mediators and antiglucose requirements, adult brain, supply-demand relationships, 205-207 inflammatory regulation, 206-207 tricarboxylic acid cycle, 215-219, 216f 632-633 epileptogenesis and, 709 transporters and pathways, 204-205 neurovascular breakdown and edema, docosahexaenoic acid (DHA) pathways histamine 631-632, 632f enzyme synthesis and breakdown, aquaporins, 632 fatty acids, long-chain carboxylic structure, metalloproteinases, 631-632 327-329, 327f mast cells, 324 phospholipid targeting, synaptic 82 - 83metabolism and methylation, 328 membranes, 645 immune-competent microglia, 23 reperfusion phase, 629-631 second messenger-independent protein neuromodulation and Ser/Thr kinases, 478-479 neurotransmission, 335 antioxidants, ischemia-reperfusion injury sodium-potassiumstorage and release, 324 protection, 630-631 adenosinetriphosphatase and, 45 lipids, 82-83, 85f excitotoxic enhancement, ROS, 631 biosynthesis, 90-96, 90f tau protein isoforms, 834-835 ischemia-reperfusion, 630 visual system, 891-892 chromatography and mass spectrometry polyunsaturated fatty acids, ROS generation, 630 Brain edema analysis, 89-90 aminoacidurias and intracranial pressure, normal adult, 91t reactive oxygen species, 629 742 neuronal extracellular clearance of spectrin-ankyrin network and, 37 aquaporin-4 regulation, 59-60 Brain metabolism, cardiolipin, 81, 86f, 87f potassium and water, 58 Brain endothelial cells (BECs) neuronal nicotinic acetylcholine receptor Brain neoplasms, stem cells as, 562 central nervous system homeostasis, 16-17 family, 271 Brain slices, brain energy metabolism assays, cerebral capillaries, 18 nonketotic hyperglycinemia and, 744–745 sodium-dependent D-glucose symporter, 52 plasma and cerebrospinal fluid levels and, Brainstem, pain management, 931–933 transport function, 19, 20f Brain ventricles, ependymal cells in, 16, 16f

Branched-chain amino acids major pathways, 740f	Lambert-Eaton syndrome, antibodies, 794 malignant hyperthermia mutations, 793	Carbon monoxide, intercellular signaling, 256 Carboxylic-acid transporters, bacterial
maple syrup urine disease, 742–743 Branching enzyme deficiency, 767, 770–771	mood disorders and, 1029–1030 muscle membrane excitation and	expression, 53 Cardiolipin, brain metabolism, normal brain,
Brody disease, sarcoplasmic reticulum calcium ATPase and, 793	contraction, 787–789, 788f overloading	neurodegeneration and gliomas, 81, 86f, 87f
С	ischemia and toxicity, 464, 627–628, 628f measurement, 456–457, 456f	Cardiotonic steroid signal receptors, sodium-potassium-
CA3 pyramidal neurons, hippocampal	indicator protein targeting, 457	adenosinetriphosphatase, 46–48,
regulation, 708 Cadherins, cell adhesion molecules, 169–170,	monitoring optimization, fluorescence indicators, 456–457	47f Cardiovascular disease, homocystinuria and
171f	optical methods, 456–457	risk of, 747
extracellular cadherin, 169, 172f homophilic type I cadherins, 169	microdomain signaling, 461 mitochondria and, 460–461, 460f	Cargo components biosynthetic secretory pathway, 127–129
integrin cross-talk, 177–178 nervous system processes, 169–170	neuropeptide release, 403 neurotransmitter receptors, G protein	intracellular membrane trafficking, 120, 121f
CAG-polyglutamine repeat diseases	coupling, 413–414	Carnitine deficiency, 767–768
epidemiology, 844–845	plasma membrane homeostasis, 457–458	Carnitine palmitoyltransferase II (CPTII)
genetics, 845t	efflux pathways, pumps and	deficiency, 766
polyglutamine disease protein functions, 845, 847f	transporters, 458 influx pathways, 458	Casein kinase 1 (CK1), phosphorylation, 478–479
acetylation, 850	primary plasma membrane calcium	Caspase substrates
ataxin-1 complex, 849	transporter, 48	apoptosis activation
ataxin-7 disruption, 849 autophagy pathway, 848f	structure, 71, 72f transport, store-operated, ligand-	postmitochondrial events, 670 synaptic plasticity, 675
gene silencing therapy, 850–853, 851f	operated, and voltage-operated	apoptosis and necrosis, 664t
misfolding and toxicity, 845–846	channels, 457f	Catabolism
phosphorylation, 849-850	photoexcited rhodopsin, 894-895	catecholamine termination, 288-290, 289f
post-translational modification, 849	ryanodine receptor, malignant	serotonin catabolic pathway, 310–311
RNA toxicity, 850	hyperthermia, 792–793	Catalytic subunits
transglutaminase inhibition therapy, 852–853	in synaptic transmission, 239–241, 243f presynaptic events, 241–245	nonreceptor protein tyrosine kinases, 494–498, 496f, 497t
turnover pathways and pathogenesis, 846–849	Calcium pumps, sodium-potassium-	sodium-potassium-
Calcium adenosine triphosphatases, basic	adenosinetriphosphatase subunits, 55, 56f	adenosinetriphosphatase pump heterodimer formation, 43
properties, 48, 49f	Calcium-stablilizing proteins, apoptosis	isoform expression, 43
Calcium/calmodulin-dependent kinases,	inhibition, 671–672	molecular structure, 43, 44f
phosphorylation, 475-476	cAMP response element binding protein	monotopic glycoproteins, 43-44
Calcium/calmodulin-stimulated	(CREB), transcription factor	sodium pump, 44–45
phosphodiesterases, 434–435 Calcium-dependent binding, proteins, 29, 31f	immunohistochemical localization, 525f protein phosphorylation, 488f, 489	Catecholamines adrenergic receptors, 295–297, 295t, 296t
Calcium ion channels	regulatory function, 524–527	G-protein-coupled receptors, 295–297
acetylcholine release, synaptic vesicles,	transgenic modeling, 525–526	agonist-induced downregulation, 297
261–262	Canavan's disease, 753	amine transporters, 289, 289f, 289t
astrocyte integration, local and global	Candidate-gene studies, Parkinson's disease,	aromatic amino acid decarboxylase,
signaling, 461–464, 463f	724–725	L-DOPA-dopamine conversion,
cerebral vasculature control, 463–464, 463f tripartite synapse, gliotransmitter and	Cannabinoids addiction, 1045–1048	285–286 biosynthetic pathway, 284f
modulation, 462–463	pain management, 933–934	tyrosine hydroxylase regulation, 284–
cellular organelles and calcium pools,	Carbamates, acetylcholinesterase inhibitors,	285, 285f
458–461	266	catechol-O-methyltransferase (COMT)
endoplasmic reticulum	Carbamyl phosphate synthetase deficiency, 750	metabolism, 291–292
intracellular calcium storage, 459	Carbohydrates	cell surface receptor binding, 293–295, 294f,
pumps, storage buffers, and release channels, 459–460	brain energy metabolism, glycolysis regulation, 208–209	294t diffusion and inactivation of, 290
signaling pathway activation, 459–460	metabolic disorders involving, 762–772	dopamine metabolites, 292
store-operated calcium entry, 460	brain metabolism, 770–772	familial dysautonomia and, 286–287
epilepsy antiseizure drugs, voltage-gated	exercise-related signs and symptoms,	knockout mice studies, 285t
current regulation, 712, 712f	768–770	adrenergic receptors, 296t
future research issues, 464–465	glucose metabolism, progressive	monoamine oxidase metabolism, 290–291,
gene subfamilies, 75–76 homeostasis, 49f, 457–458	weakness, 766 glycogen or lipid disorders, 763, 764f	291f as monoamine transmitters, 283
hypokalemic periodic paralysis, 791	muscle disorders, 763–768	neuroanatomy, 292–295, 293f
D-myo-Inositol 1,4,5-trisphosphate	Carbon-13 nuclear magnetic resonance	noradrenergic/adrenergic neurons,
liberation, endoplasmic reticulum,	spectroscopy, brain energy	dopamine-norepinephrine
448–449, 448f	metabolism, 224–225, 224f, 225f	conversion, 286

norepinephrine metabolism, 292	Cellular signaling mechanisms, 245–256	myelin components, 588-589
phenylethanolamine-N-methyltransferase,	adenylyl cyclase regulation, 328, 333f	neurite growth inhibition, 589
norepinephrine-epinephrine	astrocyte function, 256	neurotrophic factors, 590
metabolism, 288	G protein subunits, 415–416, 415f	Nogo-A inhibitor, 586, 587f, 588, 589
repeated antagonists, 297–298	intracellular signaling pathways, crosstalk,	reticulon superfamily, 587–588
reuptake and termination, 288–290	249	spinal cord injury, fiber growth and
synaptic vesicle release, 288	molecular mechanisms, cell-surface	regeneration, 592
synaptic vesicle storage, 288	receptors, 246–249, 246f, 247t	stem cell repair, 563–567
Catechol-O-methyltransferase (COMT),	first group, 246–248	tyrosine phosphorylation in, 505–511
catecholamine metabolism,	fourth group, 248–249	Central sensitization, pain management,
291–292	second group, 248	934–935, 935f
Cation antiporters, 55–56	third group, 248	descending facilitation, 937
cytoplasmic calcium regulation	nitric oxide intercellular signaling	Centronuclear myopathy (CNM), mutant
mechanisms, 55	molecule, 249–256	dynamin, 2, 123
sodium-calcium antiporters and calcium	protein phosphorylation pathways,	Cerebral blood flow (CBF)
pumps, 55, 56f	483–484	astrocytic control, calcium signaling,
cytoplasmic calcium pulses, 55	receptor-mediated signaling, 246	463–464, 463f
CB1 receptor, cannabinoid addiction,	signaling molecules, gene transcription	brain function and, 206
1045–1046	activation, 249	eicosanoids and, 656
CD9 protein, myelin sheath, 194–195	Central nervous system (CNS)	Cerebral circulation
cDNA cloning, sodium ion channel, 69–71,	blood-brain barriers and, 16–18, 17f	brain function and, 206
70f	cholesterol transport and regulation, 31, 32f	cerebral capillaries, structure and function,
Cell adhesion molecules (CAMs)	cholinergic neuron distribution, 262	18
apoptosis, 670–671	development	Cerebral energy production,
axonal regeneration, 585	axon guidance, 542–543	sodium-potassium-
catalytic subunits, sodium-potassium-	naturally occurring cell death, 542–543	adenosinetriphosphatase, 45
adenosinetriphosphatase pump,	embryology, 534	Cerebral metabolic rate (CMR), 202t
43–44	embryonic signaling, 538–539, 539f	brain development and, 205
cooperation and crosstalk, 175-178	neurogenesis and gliogenesis, 539-541	brain function, continuous cerebral
integrin-cadherin crosstalk, neurite	neuronal birthdate, 539	circulation, 206
growth, 177–178	proneural gene functions, 540–541	brain maturation, 205
interneuronal synapses, 175–177	reelin and notch signaling, cortical	glucose, functional imaging, redox state
superfamilies, 166	layer organization, 539, 539f	and metabolic pathway analysis,
cadherins, 169	diseases, blood-brain barrier dysfunction,	222–223, 223f
immunoglobulin superfamilies, 166, 167f	23	supply-demand relationships, 205-207
integrins, 170–175	embryonic development, 534	Cerebral X-linked adrenoleukodystrophy,
multiple sclerosis, 174	histamine actions in, 335–337	stem cell therapy, 565
Cell culture studies, synucleinopathies,	histaminergic fibers, 325, 326f	Cerebrovascular disease
833-834	homeostasis, 16–18	homocystinuria and risk of, 747
Cell death	immunology activity in, 603-607	phospholipase A <sub>2</sub> signaling, 654
axon-based nervous system development,	blood-brain barrier and, 604	Chanarin Dorfman syndrome, 768
542–543	injury and compensatory plasticity,	Chaperone proteins
ischemia-reperfusion injury, reactive	590-592	endocytic pathway, autophagy mediation,
oxygen species, 631	adult brain injury, Nogo-A blockade,	136–137
phosphoinositides, 452	591–592	intracellular membrane trafficking, coat
phospholipases A2, ischemia-reperfusion	neonatal damage, 590	protein removal, 124–125
signaling, 654	major components, 4f	tubulin-specific chaperone E mutations,
Cell membrane constituents	mitochondrial distribution in, 219	transgenic mice studies, 808
myelin, 184–185	mitochondrial dysfunction in, 772–773	Charcot-Marie-Tooth (CMT) disease
retrograde axonal transport, 153–154	muscarinic cholinergic receptor	gene mutations, 701
Cell-surface receptors	distribution, 277	molecular motor and, 688
axonal regeneration, neurite growth	neuropsychiatric disorders, 277	mutant dynamin, 2, 123
mediation, 589	myelin	peripheral neuropathy, 680–684
catecholamine binding, 293–295, 294f, 294t	in cell membrane, 184–185	phosphoinositides and, 445
molecular signaling mechanisms, 246–249,	lipid enrichment, 186–187, 187f, 187t	Chemical transmission, nerve cells, 235–245,
246f, 247t	peripheral nervous system myelin	236f
first group, 246–248	comparisons, 187–188	Chemokines, neuroinflammation and, 614
fourth group, 248–249	proteins in, 188–192, 190f	Chemosensing system, vomeronasal organ,
second group, 248	nociceptive pathways, 932f	910, 911f
third group, 248	oligodendrocytes, myelin production in, 13	Chemotherapy, microtubule disruption,
Cellular neuroscience	peroxisomal diseases, 760–761	114
basic principles, 4	regeneration, 451f, 585–590	Chlorine ion channels
schizophrenia, 1004–1009	axon growth, glial scar inhibition,	congenital myotonia, 792
Cellular phenotyping, transcription factors,	589–590	ligand-gated strychnine-sensitive
527–528, 527f	knockout studies, nogo gene	receptors, glycine inhibition,
transcriptome regulation, 528	development, 588	250–251

477-478

Cholecystokinin (CCK) Clathrin-coated vesicles coating removal, chaperone proteins, 124 anxiety disorders, 1032-1033 endocytic pathway, receptor-mediated monomeric and heterodimeric GTPases, identification, 390-391, 392 endocytosis, 137-139, 138f 122 plurichemical coding, neuronal signals, 403 intracellular membrane trafficking, 64f, transport vesicle coating, 72 Cholesterol 71-72 COPII-coated vesicles adult brain synthesis in astrocytes, 31-33, coating removal, chaperone proteins, biosynthetic secretory pathway, 124-125 endoplasmic reticulum coating, central nervous system transport and synaptic vesicle trafficking, 142 Golgi complex delivery, 127-129, regulation, 31, 32f Clathrin-mediated endocytosis, pinocytosis Choline, acetylcholine synthesis, storage mediation, 136 intracellular membrane trafficking and release, synaptic terminal Claudins, myelin sheath, 194 coating removal, chaperone proteins, 124 accumulation, 260-261, 261f Clinical pain management, 928-929, 938-939 monomeric and heterodimeric GTPases, Choline acetyltransferase (ChAT) genetic factors, 939 122-123 acetylcholine formation, 260 Coat proteins, intracellular membrane transport vesicle coating, 72-74 deficiency, 789 trafficking, 124-125 Copper oxidative toxicity, motor neuron Cholinergic agonists and antagonists Cobalamin-C disease, homocystinuria and, disease, 809 chemical structure, 259-260, 259f 748-749 Cori's disease, 767 mood disorders, 1024 Cobalamin-E disease, homocystinuria and, 748 Cortical-hypothalamic-pituitary-adrenal axis, nicotinic acetylcholine receptors Cocaine mood disorders, 1024 binding, 268-269 addiction, 1043 Cortical layer organization, neurogenic densensitization, 269, 270f development, reelin and notch neuronal adaptation, 1044 schizophrenia, 1008 Cochlea signaling, 539 Cholinergic disorders, muscarinic cholinergic hair cell mechanotransduction, 926 Corticobasal degeneration, 836 receptor therapies, 278 mechanisms of, 923 Corticolimbic abnormalities, schizophrenia, Cholinergic neurotransmission, REM sleep, Coenzyme Q10 deficiency, respiratory chain 1003-1004 abnormalities, 777 Corticosteroid receptors, transcription Cholinergic pathways, acetylcholine Cognitive dysfunction factors, regulatory mechanisms, synthesis, storage and release, cGMP signaling, guanylyl cyclase 522, 522f 260-262 receptors, 434 Corticotropin-releasing hormone (CRH) choline acetyltransferase catalyst, 260 G proteins and, 420 anxiety disorders, 1032 neuron distribution, central nervous nicotinic acetylcholine receptor targeting, neuronal synthesis, 393-394 system, 262, 262f Cranial nerves, taste bud, 912 synaptic terminal, choline accumulation, protein phosphorylation and enhancement Creatine phosphatase, brain energy 260-261, 261f strategies, 486-487 metabolism, 218 vesicular transporters, calcium-dependent serotonin effects, 301-304 Creutzfeld-Jakob disease neuronal release, 261-262, 262f urea cycle defects, 752 etiology, 874 genetics, 730-731 Choline transporter, neurotransmitter Collective co-spiking, neural cliques, memory function, 974, 979f function, 54 prion proteins, 875 Collybistin, glycine receptor structure and Choroid plexus, extracellular fluid control, 18 Crosstalk function, 251, 251f Chromatin immunoprecipitation assay cell adhesion molecules, 175-178 (ChIP), transcription analysis, submembrane gephyrin aggregation, 252 cadherin-integrin cross-talk, 177-178 518-520, 521f Compensatory plasticity, adult central molecular signaling mechanisms, cell Chromatin modulation nervous system, Nogo-A surface receptors, intracellular blockade, 591-592, 591f signaling pathways, 249 apoptosis activation, 670 Concept cells, memory function, 975, 979f Cyclic adenosine monophosphate (cAMP) transcription co-regulators, 516 addiction and upregulation, 1042-1043 Chromatography, brain lipids, 89-90 Conditional gene knockout technology, Chronic inflammatory demyelinating learning and memory research, adenylyl cylcase polyradiculopathy (CIDP), 699 969, 969f brain signaling function, 329-331 peripheral neuropathies, 684-687 Cone phototransduction molecular targeting, 329 Chronic wasting disease (CWD), 874 bipolar cell signaling, 897 production biochemistry, 324, 326f Circadian rhythms visual function, 895-897 histamine activity, histamine H2 receptor, autism spectrum disorders, 1016 Congenital fibrosis of extraocular muscles 1 serotonin modulation, 312 (CFEOM1), molecular motor and, protein kinase A, phosphorylation, 473 stress and disruption of transcription regulation, 524-527, 524f, Cis-Golgi network, biosynthetic secretory Congenital fibrosis of extraocular muscles 3 525f, 526f pathway (CFEOM3), TUBB3 mutation, 115 Cyclic GMP-gated ion channels, guanylyl organelle polarization, 129 Congenital myasthenic syndromes, 789-790 cyclase receptors, 433 protein and lipid transport, 130-131, 131f Constitutive secretory pathway, eukaryotic Cyclic guanosine monophosphate (cGMP) Citrate, brain energy metabolism, astrocyte cells, 133f, 134 guanylyl cyclase molecular effectors, synthesis and release, 218 Cooperation, cell adhesion molecules, signaling mechanisms, 433-434 Citric acid cycle. See Tricarboxylic acid (TCA) brain function, 433-434 175-178 Cooperativity, learning and synaptic cGMP-gated ion channels, 433 cycle Citrullinemia, 750 plasticity, 966 cognition and mood, 434 c-jun NH2-terminal kinases, phosphorylation, COPI (coatomer), intracellular membrane pain management, 434

trafficking

phosphodiesterases, 433

protein kinase G, 433 Cytoskeleton cytoskeleton and organization of, early synaptic plasticity, learning and memory, glycine receptor, pentamer assembly and differentiation, 111-112 interaction, 252 cytoskeleton composition and molecular signaling mechanisms, cell growth cone elements, 110f organization, 104f epilepsy, sprouting, dentate granule intracellular membrane trafficking, coating surface receptors, 248 phosphodiesterase regulation, 435-436 removal, chaperone proteins, circuits, 709 phototransduction, 896f 124-125 lipid mediation pathways, 658 protein kinase G phosphorylation, 473 lipid raft interaction, 35-36, 36f motility and synaptic activity, 361 2':3'-Cyclic nucleotide 3'-phosphodiesterase, membrane protein interaction, 34 transport mechanisms, molecular sorting, central nervous system myelin, neuronal 155 190-191 complementary distributions and Dentate granule cells, epilepsy Cyclic nucleotide-gated (CNG) channels functions, 112-116 axonal/dendritic sprouting, excitatory adenylyl cylcase molecular targeting, molecular components, 102-110 synaptic transmission, 709 CA3 pyramidal neuron regulation, 708 329-335 actin microfilaments, neuronal growth phototransduction, 896f and secretion, 108-110 inhibitory/excitatory synaptic input Cyclic nucleotides. See Adenylyl cyclases eukaryotic cell definition, 102, 102f abnormalities, 709 adenylyl cylases, 423-430 micofilament proteins, 109t, 110f Depolarization, action potential propagation, antidepressant mechanisms, 437-438 microtubules, structure and organelle future reserach issues, 439 tracking, 102-106, 103f, 104f, 105t, Depression guanylyl cyclases, 430-434 inflammation, cytokines, and glutamate, phosphodiesterases, 434-438 neuronal and glial intermediate 1034 second messenger hypothesis, 423, 424f filaments, morphology support, sleep disorders and, 987 spatiotemporal integration in neurons, 106-108, 107f acetylcholine and pain and, 988 438-439 neuropathology and alterations, 114-116 glutamate modulation, 992-993 Cyclin-dependent kinases 5 (CDK5),  $\beta$ -III tubulin mutations and, 115 Diabetes insipidus, vassopressin production, phosphorylation, 478 ultrastructure and molecular 404 Cyclooxygenases organization, 110-112 Diabetic neuropathy, 684, 685f arachidonic acid conversion, 648-649, 648f, protein expression Diacylglycerol kinases injury and regeneration, 114 brain injury, lipid breakdown, 654-655 arachidonic acid metabolites, 652 phosphorylation and neuropathology, lipid mediation, 654 Diet and nutrition hippocampal kainic-acid-induced 116 slow axonal transport, 155-156 amino acid disorders cyclooxygenase-2 expression, 654 ischemia-reperfusion process and spectrin-ankyrin network, 34-35 low-protein diet, 742 accumulation of, 656 Cytosol compartment maple syrup urine disease, 743 lipid mediator pathways, 652-653 brain energy metabolism, malate-aspartate myelin formation and stability, 701-702 neuroprotectin D1 inhibition, 657 shuttle, mitochondrial transfer, peripheral neuropathies and, 687 210-211 platelet-activating factor transcriptional sulfur amino acid metabolism disorders, 747 glutamate symporter failure, 54 activator, 652 urea cycle defects, 751 Cytosolic phospholipases A2, bioactive lipid synaptic plasticity, 652-653 Diffusion mechanisms, catecholamine Cys-loop ligand-gated ion channel family, formation, 647 inactivation, 290 nicotinic acetylcholine receptors, Diffusion tensor imaging, white matter D pathology, 196-197 Cystathionine synthase, sulfur amino acid Danger-associated molecular patterns Disinhibition, pain management, 937-938 metabolism disorders, 747 Disulfide bridging, secretory phospholipases (DAMPS) APC function and T-cell differentiation, 602 A<sub>2</sub>, 647 Cysteine residues, protein tyrosine phosphatases, active site, 503-504 neuroimmunology, 597 DNA damage, apoptosis activation, 668 Cytokines neuroinflammation, 616-617 DNA methylation apoptosis, 670-671 Deafness, genetics, 922 histone and, 517-518 depression and, 1034 Death receptor, apoptosis activation, 668, 669f S-adenosylmethionine transfer, microglia production, 614 Debrancher enzyme deficiency, 767, 770 neurodegenerative disease neurotrophic, 555-556 Declarative memory, 965 epigenetics, 731-733 Cytoplasmic calcium pulses Default mode network, Alzheimer's disease DNM2 gene, neuromuscular disorders, 123 regulation mechanisms, 55 diagnosis, 816 Docosahexaenoic acid (DHA) pathways sodium-calcium antiporters, 55 Dementia brain injury, lipid breakdown, 654-655 lipid mediation, 656-657 Cytoplasmic elements Alzheimer's disease, 816 brain energy metabolism, malate lipid peroxidation, 657 frontotemporal dementia, genetics, dehydrogenase, 217 726–727, 726t, 727t neuroinflammation, 614-616, 615f immunoglobulin cell adhesion molecules, Lewy bodies, genetics, 725-726, 833f neuroprotectin D1 derivation, 657 169 sodium-potassiumphospholipases A2, ischemia and seizures, neuronal axonal transport, 159-160 adenosinetriphosphatase and, 45 647 receptor protein tyrosine kinase, 498-501 retinal identification, 657 Demyelination consequences of, 580 slow axonal transport, 155-156 sequential oxygenation, resolvin/protectin repair, 702-703 Cytoplasmic signaling enzymes, mediation, 657 metabotropic glutamate receptors, Dendrites, 4-6, 5f stroke penumbra protection, 635-638, 636f, as afferent components, 9, 9f

Docosanoids, lipid mediation, 657 Drug therapy Embryonic stem cells, derivation, 559 alcohol addiction, 1049-1050 Dominant optic atrophy (DOA), dynamin Emergenesis, autism spectrum disorders, proteins and, 124 antiseizure drugs, epilepsy and 1014 Doogie mice, learning and memory research, mechanisms of, 711-713 Endacannabinoids 969-971 GABA-mediated synaptic inhibition, CB1 receptor ligands, 1046 NR2B targeting, 972-973 711-712, 712f retrograde messengers, synaptic plasticity, Dopa decarboxylase. See Aromatic amino voltage-gated calcium currents, 712, 712f 1046–1047, 1047f acid decarboxylase (AAAD) voltage-gated sodium channel targeting, End-binding proteins, microtubule Dopamine 711, 711f organization, 106 addiction and neurotransmission autism spectrum disorders, 1014 Endocytic-exocytic cycling mechanisms, 1038-1040, 1040f, basal ganglia disorders, 868 sodium-potassium-1042f brain histamine and, 337-339 adenosinetriphosphatase adenylyl cyclase targeting, striatal GABA<sub>A</sub> receptors, 372-374 plasmalemma regulation, 45, 46f signaling, 430 G proteins and, 420 synaptic transmission, presynaptic events, aromatic amino acid decarboxylase neuropeptide receptors, 402 L-DOPA conversion to Parkinson's disease, 863-864 Endocytic pathway, intracellular membrane autism spectrum disorders, 1015 phosphodiesterase targeting, 438 trafficking, 120, 135-139 in basal ganglia, 859-860, 859f tardive syndromes and, 868 macromolecular degradation and nutrient cell-surface receptor binding, 293-295, 294f, transcription targeting, 528-529 uptake, 135-137 294t Dual-specificity phosphatases (DUSPs) receptor-mediated endocytosis, 137-139, metabolites, 292 phosphorylation, 481 138f norepinephrine conversion, adrenergic/ protein tyrosine phosphatases, 505, 506f Endocytosis noradrenergic neurons, 286 Dual-transport model, biosynthetic secretory GABA receptors, refractory status sleep regulation, 988-989 pathway, protein and lipid epilepticus, 373 Dopamine-acetylcholine balance, in basal transport, 131 Dynactin p150<sup>Glued</sup>, familial amyotrophic synaptic transmission, presynaptic events, ganglia, 860 244 Dopamine-β-hyroxylase, dopaminelateral sclerosis, 804 Endoplasmic reticulum (ER) norepinephrine conversion, transgenic mice studies, 808 biosynthetic secretory pathway adrenergic/noradrenergic COPII-coated vesicles, Golgi complex Dynamin proteins delivery, 127-129, 128f neurons, 286 intracellular membrane trafficking, vesicle Dopamine depleting agents, basal ganglia and organelle targeting, 123-124 rough vs. smooth classification, 122f, disorders, 868 mutant dynamin 2 and neuromuscular 126-127 Dopamine hypothesis, schizophrenia, disorders, 123 calcium ion channels 1004-1005 **Dyneins** intracellular calcium storage, 459 Dopamine receptor blocking agents, basal pumps, storage buffers, and release axonal transport ganglia disorders, 868 biochemical properties, 157 channels, 459-460 signaling pathway activation, 459-460 Dopamine receptors, psychomotor stimulant molecular motor attachment, 158 addiction, 1045, 1046f neuronal cytoplasm, 159-160 store-operated calcium entry, 460 Dopaminergic system, mood disorders, 1024 molecular motor, peripheral neuropathies, cholesterol synthesis, 32-33 Dopamine transporters (DAT) D-myo-Inositol 1,4,5-trisphosphate, catecholamine termination, 289 Dysferopathies, axonal transport and calcium liberation in, 448-449, psychomotor stimulant addiction, neurodegeneration, 161 Dysmyelinating diseases, stem cell therapy, 565 lipid composition, 31 1043-1044 Dorsal horn, nociceptive pain, 930, 931f Dystonia, basal ganglia involvement, 866-867 Endoproteases, peptide biogenesis, 395-397, 396f Dorsal root ganglion, pain management, 929 Dystrophin protein comples, aquaporins, 57 Dorsoventral pattern, embryonic nervous Endothelial cells, brain energy metabolism, E system development, 534-535, transporters, glucose/ Ectoenzymes, extracellular nucleotide monocarboxylic acid uptake, 203-204, 204f Drug abuse regulation, 379 Edema, brain injury, 631-632, 632f Energy crises, phosphorylase deficiency, 763 adenylyl cyclase targeting, 430 Energy metabolism barbiturates and benzodiazepines, 1050 aquaporins, 632 basic principles, 1038, 1039f metalloproteinases, 631-632 brain function Efflux pathways, calcium pumps and cannabinoids, 1045-1048, 1047f aging and maturation declines, 205 cyclic AMP second-messenger pathway, transporters, 458 aminoaciduria disorders, 738-740 basic requirements, 202t 1042-1043 Eicosanoids dopamine transmission, 1038-1040, 1040f, cerebrovasculature source for, 656 blood-brain barrier transport, 204 lipid mediator pathways, 648-649, 648f, brain imaging and spectroscopy, ethanol, 1049 649f, 650f 222-226, 223f, 224f, 225f hallucinogens and dissociative drugs, Electrical signals, excitable cells, 65-66 cell and subcellular structures and 1050-1051 Electrolyte imbalance, muscle ion channel functions, 203 neural circuitry, 1038-1041 alteration, 798 compartmentalization, 207 neuronal plasticity, 1051-1052, 1052f Electron transport chain, brain energy developmental metabolic rate, 205 nicotine, 1048-1049 metabolism, ATP production, 217 developmental transporters and pathways, 204-205 opiates, 1041-1043 Embryology, nervous system development, psychomotor stimulants, 1043-1045, 1044f, glutamate-glutamine metabolism, 1046f cortical neuron layers, 538-539, 539f 220-222, 221f

glycogen sythesis, astrocytic Episodic cell assemblies, memory function, Extracellular cadherin (EC), cell adhesion degradation, 209-210 975-977 molecules, 169, 172f glycolysis, 207-209, 208f Episodic memory, 965 Extracellular domain imaging applications, signaling Epistasis, autism spectrum disorders, 1014 receptor protein tyrosine kinase, 498-501 mechanisms, 202-203 Equilibrative transporters (ENT) receptor protein tyrosine phosphatases, 505 lactate metabolism, 211-215 adenosine transport, 379-380, 380f Extracellular fluid (ECF) malate-aspartate shuttle, 210-211, 214f alcohol effects, 387 blood-brain barrier and choroid plexus mitochondrial heterogeneity, 219-220 Equilibrium potentials, excitable cells, 65 control of, 18 ErbB family, neuromuscular synapse, 509 glutamate symporter failure, 54 neuropathology, 226 pentose phosphate shunt, 210 ER-Golgi intermediate compartments hair cells, 919-920 signaling mechanisms, 201-202 (ERGICs), biosynthetic secretory Extracellular matrix (ECM) proteins, integrin SLC25A12 gene mutation, pathway, 127, 128f receptors, cell adhesion, 170-172 N-acetylaspartate formation and Ethanol addiction, 1049-1050 Extracellular nucleotides, purine regulation, myelination, 212-213, 212f Eukaryotic cells substrates, 203-204 cytoskeletal definition, 102, 102f Extracellular signaling, G protein activity, supply-demand relationships, 205-207 intracellular membrane trafficking, 120-121 412, 414f tricarboxylic acid cycle, 215-219, 216f neurotransmitter release, 237-238 Extracellular signaling-regulated protein carbohydrate/lipid metabolic disorders, Evoked endplate potential (EPP), synaptic kinases (ERKs), phosphorylation, 768-770 transmission exocytosis, 239, 242f Enkephalin knockout mice, neuropeptide Exchange proteins (Epac), adenylyl cylcase Extrasynaptic mechanisms, protein studies, 405-406 molecular targeting, 329 phosphorylation, 489 Environmental toxins, myelination and, 578 Excitable cells F Enzymes action potentials, 66-67 acetylcholine breakdown, 262-266 electrical signals, 65-66 Fabry disease, 759 brain energy metabolism, 207, 207t membrane phospholipids, transmembrane Facilitated diffusion glycogen regulation, 210 ion gradients, 644 aquaporins, 56-58 histamine synthesis and breakdown, 327, negative membrane potential, 64-65, 64f glucose and myoinositol, 58-60 nonequilibrium in, 65 Familial Alzheimer's disease, 817 327f  $\label{eq:Familial amyotrophic lateral sclerosis (FALS)} Familial amyotrophic lateral sclerosis (FALS) \\ dynactin p150^{Glued} mutation, 804$ myelin, 195-197 Excitatory neuronal signals peptide biogenesis, 394-399, 394t, 396f brain energy metabolism, 205-206 Ependymal cells, in brain ventricles and epilepsy epidemiology, 803-806 genetics, 727-729 spinal cord canal, 16, 16f axonal and dendritic sprouting, 709 Epigenetic modifications, neurodegenerative dentate granule cells, input wild-type SOD1 misfolding, 809-811 diseases, 731-733 abnormalities, 709 SOD1 mice studies, 807 **Epilepsy** disruption, 706-708, 707f Familial dysautonomia, catecholamines and, antiseizure drug mechanisms, 711-713 glutamate-glutamine cycle, 221-222 286-287 GABA-mediated synaptic inhibition, Excitatory neurotransmitters, glutamate, 343 Farber disease, 757 711-712, 712f Excitatory postsynaptic potential, glutamate Fast channel syndrome, 790 voltage-gated calcium currents, 712, 712f receptor production, 356-358, 357f Fatty acids voltage-gated sodium channel targeting, brain energy metabolism, 219-220 Excitotoxicity brain injury, ischemic phase, 627 711, 711f glycerolipid composition, 83-85, 84f axonal and dendritic sprouting, dentate glutamate receptors, 363 hydrophobic lipids, 82 granule circuits, 709 ischemia, 627 ischemia and release of, signaling cascades, CA3 pyramidal neuron, hippocampal ischemia-reperfusion injury, reactive 655-656 regulation, 708 oxygen species, 631 long-chain carboxylic structure, 82-83, 83f cellular hyperexcitability, hippocampal necrosis and, 673 metabolic disorders involving, 762-772 electrophysiology, 708 Exercise-related pathologies, carbohydrate/ brain metabolism, 770-772 dentate granule cells, animal models, lipid metabolic disorders, 768-770 exercise-related signs and symptoms, inhibitory/excitatory synaptic Exocytosis 768-770 input abnormalities, 709 neurotransmission, synaptic vesicle glucose metabolism, progressive epidemiology, 705 trafficking, 139-142 weakness, 766 epileptogenesis, 709 serotonin vesicle storage, 306-308, 307f, 308f glycogen or lipid disorders, 763, 764f molecular mechanisms, 710-711 synaptic transmission, 237f, 238 muscle disorders, 763-768 prevention, 710 calcium ion channels, 239-241, 243f oxidation, 765f, 772 genetics, 713-717, 713t, 714t production rate and ischemia resistance, 656 quantal analysis, 239, 242f spontaneous and engineered mutations, Exogenous material, retrograde axonal Fear, neurochemistry, 1030-1033 mouse studies, 715-717, 715-716t transport, 153-154 Feature-encoding pyramid, memory function, inhibitory/excititatory synaptic Exome sequencing, amyotrophic lateral neural cliques, 974-975, 978f transmission disruption, 706-708, sclerosis genetics, 806 Feeding behavior and food intake, serotonin Exonic mutations, MAPT gene, 836-837 modulation, 312-313 terminology and classification, 705-711, 706t Exoproteases, peptide biogenesis, 395-397, Fenfluramine, serotonin transporter and, 307 Epileptogenesis 396f Fibrous astrocytes, 12, 12f Fimbrin, neuronal and glial morphologies, molecular mechanisms, 710-711 Experimental allergic encephalomyelitis prevention, 710 109-110 (EAE) cyclooxygenase-2 and synaptic plasticity, multiple sclerosis modeling, 697 Fish venom, muscle excitation alteration, 652-653 myelin basic protein and, 189 796-798

Five-carbon branched chain, isoprenoids, 82 physiology and pharmacology, 368-369 Glc-6-P substrate, brain energy metabolism, Fluorescence indicators, calcium signal brain distribution and utilization, monitoring, 456-457, 456f 368-369 Glial cell line-derived neurotrophic factor refractory status epilepticus, endocytosis, FM1-43 fluorescent probe, synaptic (GDNF), 553-554, 554f transmission, endocytosis, 244, 373 GFL receptors, 554-555 structure and function, 369-375 Glial cells FMRF-amide-gated sodium ion channel, Ganglion cells ATP-adenosine signaling, 384–385 optic nerve axons, 890-891 peptide expression, 402 respiration and sleep, 385-386 Focal cerebral ischemia, 622-623, 622f, 623f pain management, 929 development, neural stem cells, 559-561, 560f Folic acid, homocystinuria and remethylation Gasotransmitters, intercellular signaling, 256 intracellular membrane trafficking, 120-121 deficit, 748 Gastrin, identification, 391-392, 391f mitochondrial heterogeneity in, 219-220 Forbe disease, 767 Gaucher disease, 757-758 prostaglandin release, 648-649, 650f Fragile X syndrome, autism spectrum Gene encoding schizophrenia, 1008-1009 Glial fibrillary acidic protein (GFAP) disorders, 1017-1018 acetylcholinesterase, 263 Free inositol, inositol phosphate metabolism, nociceptive response, 939 cytoskeletal expression, injury and 449, 449f Parkinson's disease mutations, 832-833 regeneration, 114 Free radical peroxidation, apoptosis and, prion proteins, 874-875 neuronal and glial morphologies, 108 665-667, 666f Gene expression, addiction and, 1051 Glial filaments Frontotemporal dementia General-to-specific feature-encoding neural axonal cytoskeleton organization and, genetics, 726-727, 726t, 727t clique assemblies, 974-975 112-114, 113f MAPT mutation, 836, 837f Gene silencing therapy, polyglutamine repeat neuronal and glial morphologies, 106-108, Fructose-1,6-bisphosphatase deficiency, 771 diseases, 850-853, 851f FTDP-17 neurological disorders, cytoskeleton Glial scar, axonal growth and, 589-590 Gene splicing alterations and, 114 acetylcholinesterase, 263, 263f Gliogenesis, nervous system development, Functional magnetic resonance imagiong histamine H<sub>3</sub> receptor, 333 539-541 (fMRI) peptide diversity, 399-400, 401f neuronal birthdate, 539 brain energy metabolism, 223 Gene-targeted therapy, Alzheimer's disease, proneural gene functions, 540-541 mood disorders, 1025-1026 821-822 reelin and notch signaling, cortical layer FUS gene, amyotrophic lateral sclerosis, Genetically encoded calcium indicators organization, 539, 539f 804-805 (GECIs), calcium signal Gliomas, cardiolipin, 81, 86f, 87f monitoring, 457 Global brain assays, brain energy G metabolism, 222 Genetic disease GABAergic neurons. See also γ-Aminobutyric autism spectrum disorders, 1013, 1014 Global cerebral ischemia, 623, 626f acid ion channel mutations, 77 Globoid cell leukodystrophy. See Krabbe anxiety disorders, 1031 myelination, 576-577 basal ganglia and movement control, 857 myelin disorders, 699-701, 700t Glucocorticoid receptors, transcription factors, 521-524, 523f glutamate-glutamine cycle, 222 neurodegenerative disease Alzheimer's disease, 721-723, 721t Glucocorticoid response element (GRE), glycine receptors and, 251, 253 mood disorders, 1024 amyotrophic lateral sclerosis, 727-729, transcription factors, 523 schizophrenia and, 1007-1008 Glucocorticoids sleep and wakefulness, 991 Creutzfeld-Jakob and other prion hippocampal stress effects and, 949-953 GABA shunt, 368, 369f diseases, 730-731 mood disorders and, 1026 γ-Aminobutyric acid (GABA) epidemiology, 719-721 Glucose in basal ganglia, 858f, 859-860 epigenetic modifications, 731-733 brain development, cerebral metabolic epileptic anti-seizure drugs, synaptic frontotemporal dementia, 726-727, 726t, rate, 205 inhibition, 711-712, 712f brain energy metabolism, 206-207 GABA shunt, 368, 369f Huntington's disease, 729-730 acetyl coenzyme formation, 218-219 GABA transaminase deficiency, 753 Lewy body dementia, 725-726 functional imaging, redox state and inhibitory neurotransmitter function, 375 mutation and polymorphism metabolic pathway analysis, metabolic disorders, 752-753 identification, 721t 222-223, 223f Parkinson's disease, 722t, 723-725, 723t, congenital defects, 752-753 lactate as fuel, 214-215 sleep regulation, 990-991 724t metabolic fates, 207, 208f synthesis, uptake and release, 368 triplet repeat disorders, 729-730 oxidation, pyruvate dehydrogenase, 217 tyrosine phosphorylation, 511 neuromuscular junction disorders, 789-790 pyruvate conversion (glycolysis), 207–209 γ-Aminobutyric acid (GABA) receptors peripheral neuropathies, 680-684, 681-682t brain function and, 201-202 GABA<sub>A</sub> receptors schizophrenia as, 1009-1010 facilitated diffusion, 58-60 Gene transcription, molecular signaling drug targeting, 372-374 glutamate derivation, 343-344 ligand-gated ion channel family, 370, mechanisms, cell surface Glucose-6-phosphatase deficiency, 771 370f, 371f, 372t receptors, 249 Glucose transporters (GLUT 1,2,3) mouse genetics, 375 Genome screening blood-brain barrier, transport defects, 770 neurosteroids, 374 Alzheimer's disease, 722-723 brain energy metabolism endothelial cell uptake, 203-204, 204f three-dimensional ligand-gated ion Parkinson's disease, 724-725, 832-833 channel structures, 374-375 Gephyrin, glycine receptor structure and neuropathology, BBB alteration, 204 GABA<sub>B</sub> receptors function, 251, 251f facilitated glucose diffusion, blood-brain G protein coupling, 369 submembrane aggregation, 252 barrier, 58-59 heterodimers, 369-370 GFL receptors, 554-555 motor neuron disease, 808

Glutamate	subunits, 348-350, 350f	Glycine transporter 2 (GlyT2), glycinergic
agonist-binding site, 354	kainate receptors, 350, 351f	neurotransmission and mutation
	metabotropic receptors, 347, 349f	in, 254
in basal ganglia, 858		*
blood-borne glucose derivation, 343–344, 344f	classification, 358	Glycogen
brain energy metabolism, 219–220	cytoplasmic signaling enzymes, 358	brain energy metabolism
0,	genetic knockout studies, 359	astrocyte degradation, 209–210
glutamate-glutamine	ion channel modulation, 358–359	enzyme-regulated steady-state
compartmentalization, 220–222, 221f	presynaptic activation and inhibition, 359	concentration, 210 muscular metabolic disorders, 763, 764f
	synaptic transmission, 358–359	Glycogenosis type IV, 763
cocaine and amphetamine addiction, 1044	NMDA receptors, 350–354, 351f, 352f	, ,
dendritic motility, 361 excitatory neurotransmission, 343	splice variants and RNA editing, 354–356 transmembrane topology, 354	Glycogen phosphorylase, brain energy metabolism, 210
excitatory postsynaptic potentials, 356–358	Glutamatergic system, mood disorders, 1024	Glycogen synthase kinase (GSK3)
genetic regulation, 354–356, 355f	Glutamine Glutamine	brain energy metabolism, 210
glutamatergic synapse potentiation/	glutamate precursor, 344–346, 345f	mood disorders and, 1027, 1029
depression, learning and, 346–347	sodium-dependent glutamine transporters,	Glycogen-synthase kinase-3 (GSK3),
glutamine cycle, 344–346, 345f	astrocyte to neuron glutamine	phosphorylation, 478
ketoglutarate loss, tricarboxylic acid	transfer, 362	Glycogen synthetase deficiency, 772
cycle, 345–346	urea cycle defects, cognitive function and,	Glycolysis
neuronal autoimmune encephalitis, 353	752	brain energy metabolism, 207–209, 209f
neurotoxicity and excitotoxicity, glutamate	Glutamine cycle, glutamate precursor,	ATP, pyruvate and amino acid/
analogs, 363	344–346, 345f	carbohyrate precursor production,
postsynaptic diffusion, 359–360	Glutamine lactate, brain energy metabolism,	208–209
presynaptic terminal release, 645–646, 646f	219–220	hexokinase regulation, 207–208
protein intracellular mediation, receptor	γ-Glutamylcysteine synthetase deficiency,	phosphofructokinase regulator, 208
activation, 360–361	752, 753f	brain metabolic disorders, 771
PSD95 scaffolding protein, 360–361	γ-Glutamyltranspeptidase deficiency,	enzymatic glycolytic defects, 764–767
small GTP-binding proteins, 361	752–753, 753f	muscular metabolic disorders, 764f
Q/R site, 354–356, 356f	Glutathione metabolism, disorders of, 752, 753f	Glycoproteins
rod and cone release, photoreceptor	Glutathione synthetase deficiency,	central nervous system myelin, 191–192
downstream signaling, 897	5-oxoprolinuria, 752	hormones, 391–392, 391f
sleep and wakefulness regulation, 991-992	Glutmaesamate, depression and, 1034	peripheral nervous system myelin, 192-193
sodium-dependent transporters, astrocyte-	Glycerol	Glycosylation, biosynthetic secretory
neuron glutamine transfer, 362	glycerolipid composition, 83–85, 84f	pathway, 126, 127t
symporters	phospholipid esterification, 645-646	membrane and secretory proteins, 129-130
pathologic failure, synaptic, extracellular	Glycerolipids	G <sub>M2</sub> gangliosidoses, lysosomal mutations,
and cytosol compartments, 54	composition, 83–85, 84f	759–760
SLC1A1-4 and SLC1A6 genes, 53-54	distribution profile, 88t	Golgi complex, 8, 8f
SLC1 proteins, 53	Glycine	axonal transport of proteins, 152-153, 153f
sodium-dependent, extracellular	biochemistry and transport, 250	biosynthetic secretory pathway
clearance, 361–362	metabolic disorders, 744–745	cisternae-based protein/lipid transport,
synaptic vesicle accumulation, 346	receptor distribution, 252–253	130–131, 131f
transmembrane topology, 354, 355f	brain and spinal cord imaging, 252	COPII-coated vesicles, endoplasmic
Glutamate-glutamine metabolism, brain	GABA-glycine neurotransmitter	reticulum delivery, 127–129, 128f
energy metabolism, 220–222	co-utilization, 253	membrane and secretory protein sorting
amino acid transporters, mitochondrial	immunocytochemical mapping, 252	and glycosylation, 129–130
membrane, 220	receptor structure and function, 251–252	organelle polarization, 129
GABAergic neurons and astrocytes, 222	cys-loop superfamily, 251	cholesterol synthesis, 32–33
glutamate-glutamine cycle, 221–222	gephyrin and collybistin accessory	Golgi-derived organelles, V <sub>0</sub> V <sub>1</sub> proton
metabolic pathways and	proteins, 251, 251f	pumps, 50, 50f
compartmentalization, 220–222,	site-directed mutagenesis studies, 252	Golgi membranes, lipid composition, 31
221f	Glycinergic neurotransmission, neurologic	GoLoco protein, G protein subunit
nitrogen shuttles, 222	disease, 250–255 glycine biochemistry and transport, 250	regulation, 416
tricarboxylic acid cycle activity, 220		GPI-anchored proteins (GPI-APs),
Glutamate receptors AMPA receptors, 350, 351f	glycine receptor distribution, 252–253 glycine receptor structure and function,	lipid rafts and, 34
central nervous system disorders, 363–364	251–252	G-protein-coupled receptors adrenergic receptors, 295–297
dietary neurotoxins, activation and cell	H <sup>+</sup> -dependent vesicular transporter, 250	catecholamine receptors, 293
death, 363	ligand-gated chloride channel, glycine	histamine activity, 329–335, 330t
excessive receptor activation, neurological	inhibition, 250–251	histamine $H_1$ receptor, 329–331
disorders, 363–365	postsynaptic effects and pharmacology,	histamine $H_1$ receptor, 321
ionotropic receptors	250–251	histamine $H_2$ receptor, 331–334
classification, 347–356, 349f	postsynaptic gene mutations, 253–254	muscarinic cholinergic receptor mediation, 274
genetic knockout studies, 358	presynaptic glycine transporter 2 mutation,	neuropeptide receptors, 400–401
permeation pathways, 48, 357f	254	taste receptors, 912–913, 913f
structural homologies, 348–350	startle disease molecular genetics, 253	signaling cascade, 913–914
<u> </u>	——————————————————————————————————————	

G protein inward-rectifying potassium	G1Pase-activating proteins (GAPs),	Doogte mice, 969–971
channel (GIRK), neurotransmitter	heterotrimeric G protein	synaptic plasticity and, 965–966
receptor coupling, 412–414	modulation, 416, 416f	Helicase gene mutation, amyotrophic lateral
G-protein-receptor kinases (GRKs), structure	GTPases	sclerosis, 803
and function, 415, 415f	G protein extracellular signaling, 412, 414f	Hematopoietic stem cells (HSC)
G proteins	intracellular membrane transport, 122–123	derivation, 559, 559f
bacterial toxins, ADP-ribosylation catalysis, 419–420	dynamin protein structure and function, 123–124	dysmyelinating disease therapies, 565
		Heme oxygenase-2 (HO-2), intercellular
diacylglycerol kinases, 654	Rab proteins, 125	signaling, 256
GABA <sub>B</sub> receptor coupling, 369	NMDA receptor activatin, postsynaptic	Hereditary canine spinal muscular atrophy
heterotrimeric structure, 411–418	density, 361	(HCSMA), motor neuron disease,
cell membrane trafficking, 415	Guanine nucleotide exchange factors (GEFs),	806–807
extracellular signaling, dissociation and	Ras small G protein, 418–419	Hereditary folate malabsorption, 749
reassociation, 412	Guanine nucleotides, phototransduction,	Hereditary motor and sensory neuropathies
functional cycle, 414f	892–894	(HMSN), peripheral neuropathy,
intracellular second messenger	Guanosine diphosphate (GDP), G protein	680–684
regulation, 414–415	extracellular signaling, 412, 414f	Hereditary muscle membrane diseases,
long-chain fatty acids, covalent	Guanosine triphosphate (GTP), G protein	790–793
modification, 418	extracellular signaling, 412, 414f	Hereditary neuronal disorders, protein
multiple nervous system structures, 412	Guanylyl cyclases	kinase/phosphatase mutations,
neurotransmitter ion channel coupling,	cGMP signaling, molecular effectors,	489–491, 490t
412–414	433–434	Hereditary neuropathy with liability to
phosphorylation, 418	brain function, 433–434	pressure palsies (HNPP), 682
protein modulation, 416–418, 416f, 417f	cGMP-gated ion channels, 433	Hereditary sensory-motor neuropathy, Rab
subunits, 412, 413t, 415-416, 415f	cognition and mood, 434	protein and, 421
transmembrane signaling, 411–412	pain management, 434	Hereditary spastic paraplegias, axonal
intracellular membrane transport, 122–123	phosphodiesterases, 433	transport deficits and pathogenic
metarhodopsin II activation, 895f	protein kinase G, 433	mechanisms, 146
molecular signaling mechanisms, cell surface receptors, 248–249	synaptic plasticity, learning and memory, 434	Heterodimeric GTPases, intracellular membrane transport, 122–123
muscarinic cholinergic receptors, 276, 276f	GC-A, -B, and -C receptors, natriuretic	Heterodimeric structures, GABA <sub>B</sub> receptors,
neuropathology and disease, 420, 421	peptides, 432	369–370
phosphodiesterase activation, retinal	GC-D and GC-G, olfaction, 432	Heterosynaptic depression, astrocyte-
phototransduction, 436–437	GC-E and GC-F, photoreceptor signal	mediated, adenosine-dependent
small G proteins, 418–419, 418t	transduction, 432	action, 385
Rab family, 419, 419f	membrane-bound structure, 431-432, 431f	Heterotrimeric G proteins, 411–418
Ras proteins, 418–419	soluble compounds, 432–433	cell membrane trafficking, 415
G-protein-subunit/cyclic adenosine	nitric oxide regulation, 433	extracellular signaling, dissociation and
monophosphate (CAMP)-	Guillain-Barré syndrome	reassociation, 412
generating signaling pathway,	demyelination and, 698–699	functional cycle, 414f
mood disorders and, 1027	peripheral neuropathies, 684-687, 686f	intracellular second messenger regulation,
Growth cone motility	Gulf War syndrome, acetylcholinesterase	414–415
cytoskeleton, 110f	inhibition, 279-280, 280f	long-chain fatty acids, covalent
microfilament and microtubule dynamics,	, ,	modification, 418
112	Н	multiple nervous system structures, 412
Growth factors	Hair cells	neurotransmitter ion channel coupling,
basic properties, 546	mechanotransduction, 918-923, 919f, 920f	412–414
glial cell line-derived neurotrophic factor,	cochlear cells, 926	phosphorylation, 418
553–554, 554f	inner ear, 923	protein modulation, 416–418, 416f, 417f
GFL receptors, 554–555	stereocilia actin, 921–923	subunits, 412, 415–416, 415f, 413t
mood disorders, 1025	transduction and adaptation, 920f	transmembrane signaling, 411–412
in nervous system, 557t	Halle Berry cells, memory function, 975	Hexokinase, brain energy metabolism and
neuregulilns, 555	Hallucinogen addication, 1050	regulation of, 207–208
neurotrophic cytokines, 555–556	H <sup>+</sup> -dependent vesicular transporter, glycine	High-affinity transporters
neurotrophin receptors, 551–553	transport, 250	choline accumulation, synaptic terminals,
p75 neurotrophin receptor, 552–553, 553f	Head rotation, vestibular organs, 923–925	260–261, 261f
Trk receptors, 552, 552f	Hearing	secretory phospholipases A <sub>2</sub> , 647–648
neurotrophins, 547–551, 547f, 548f	cochlea, 923	High-frequency sound detection, cochlear
brain-derived neurotrophic factor,	cochlear hair cells, 926	anatomy, 925–926
548–550	deafness genes, 922	Hippocampus
nerve growth factor, 547–548	hair cells, 918–923	epileptic electrophysiology
neurotrophin, 3, 550	high-frequency sound detection, 925–926	CA3 pyramidal neuron regulation, 708
neurotrophin, 4, 550–551	inner ear anatomy, 924f	cellular hyperexcitability, 708
<u>*</u>		**
proneurotrophins, 551, 551f	prestin electromotility, 925f  Heat shock proteins, transcription factors, 523	kainic-acid-induced cyclooxygenase-2
regulation, 551	Heat shock proteins, transcription factors, 523	expression, 654
stem cell sources, 565–566	Hebb's rule, learning mechanisms	memory function

concept cells, 975 Histidine decarboxylase (HDC) Hypocretins, sleep regulation, 989-990 generalization function, 977-978 brain histamine synthesis, 328 Hypoglycemia, brain energy metabolism imagination and, 978-979 genetic derivation, 328 blood-brain barrier alteration, 204 real-time memory visualization, 976f L-Histidinie, brain histamine synthesis, 328 partial TCA cycles and, 219 retrograde and post-learning Hypokalemic periodic paralysis, 791 consolidation, 971 nucleosome modification, Hypothalamic pituitary adrenal (HPA) axis neuronal pathways, memory formation neurodegenerative disease anxiety disorders, 1032 and, 347, 348f epigenetics, 731-733 autism spectrum disorders, response stress effects on, 947-949 transcription, DNA methylation and, 517-518 systems, 1015 structure and function, 947-949 Histone acetylation stress and brain function and, 946 synaptic plasticity, pathways and, 966f neurodegenerative disease epigenetics, Hypothalamus, tuberomamillary region, Histamine 731-733 histaminergic fibers, 324, 326f brain dynamics, 327-329, 327f transcription, 516, 517f Hypoxia-inducible factor (HIF), brain 1-histidine and HDC activity, 328 Histone deacetylase inhibitors, function and, 206 brain storage and release, 324 neurodegenerative disease Hypoxia response element (HRE), brain cell anatomy and morphology, 324-327 epigenetics, 731-733 function and, 206 chemical structure, 324, 325f H/KDEL receptor, biosynthetic secretory Hypoxic conditions, brain energy daytime sleepiness and narcolepsy, 338 pathway, COPII-coated vesicles, metabolism, lactate formation, drug action, 337-339 endoplasmic reticulum delivery, central nervous system disease, 337-339 HMIT symporter, 59 pain perception, 337 sleep-wake cycles and appetite, 337 Homeobox genes, central nervous system IDPN, neurofilimentous axonal pathology, enzyme synthesis and breakdown, 327 development, rostrocaudal axis, fiber distribution, central nervous system, 535-538, 537f Immune-mediated neurodegenerative 325, 326f Homeostasis disorders, 598 ionotropic transmission modification, 335 Immune response, nerve injury, 938-939 calcium ion channels, 49f, 457-458 methylating enzyme central nervous system, 16-18 Immune tolerance, neuroimmunology, 601-602 distribution outside nerve terminals, tight junctions, 16-17 Immunocytochemical mapping, glycine microglial sensors for disruption of, 618 328-329 receptor distribution, 252 metabolism and, 328 sleep regulation, adenosine and, 993 Immunoglobulin superfamily, cell adhesion polymorphism (Thr105Ile), 329 Homocitrullinuria, 751 molecules molecular action sites, 329-335 diversity and structure, 166-168, 168f Homocysteine, homocystinuria and cyclic AMP synthesis, 331 methionine formation, 748 protein immunoglobulin-like domain, 166, G-protein-coupled receptors, 329 Homocystinuria, 745-749, 746f intronless H<sub>1</sub> receptors, 329–331 Homosynaptic facilitation, pain management, Immunomodulation, stem cell sources, 566 nervous system actions, 335-337 935-936 Impulse conduction, myelin facilitation, diseases and disorders, 337 Hormesis-based mechanisms, apoptosis 180-181, 181f neuromodulation and inhibition, 671 Indicator proteins, calcium signal monitoring, neurotransmission, 335 H-Ras protein, lipid rafts and, 34 neurotransmitter connections, 335-336, Human kinome, 471f Indolealkylamine 5-hydroxytryptamine, Huntington's disease identification as serotonin, 301 physiological functions, 336-337 animal models, 865 Infantile acid maltase deficiency, 770 neuron morphological and membrane basal ganglia involvement, 865-866 Infection properties, 325 connectivity losses in, 869-870 myelin diseases and, 692-699 genetics, 729-730, 865, 866f neuron storage and release, 328 peripheral neuropathies, 687 physiological and pathological functions, polyQ-htt enzymatic aberration, 731-733 Inflammasome, neuroinflammation, 616-617 324 molecular aspects, 865, 866f Inflammatory processes receptors, 330t transcription factors, 519 microglia and, 15-16, 15f gene splicing, 332f pain management, 929f, 934-936 treatment, 865-866 H<sub>1</sub> receptors, 329-331 Hydroperoxides (HpETEs), lipoxygenase Influx pathways, calcium entry, 458 H<sub>2</sub> receptors, 331 formation, 653 Inherited diseases, purine metabolism, 381 H<sub>3</sub> autoreceptors, neuron regulation, 329 Hydrophobic lipid bilayers Inhibitory neuronal signals H<sub>3</sub> receptors, 331–334, 333f, 337–339 isoprenoids or fatty acids in, 82 brain energy metabolism, 205-206 H<sub>4</sub> receptors, 334-335 polar water molecule diffusion, 56-57 intracellular messengers, 330-331, 5-Hydroxytryptamine (5-HT). See Serotonin dentate granule cells, input 333-334, 335 Hyperammonemia, 751 abnormalities, 709 disruption, 706-708, 707f signaling pathways, 334f Hyperekplexia sleep and wakefulness, 987 glycine transporter 2 mutation, 254 Injury, cytoskeletal protein expression, 114 tuberomamillary fibers, hypothalamic molecular genetics and pathphysiology, 253 Innate immunity origin, 324, 326f GlyRα1 mutations, 253 alarm signals, 599 Hyperexcitability, hippocampal Histamine decarboxylase, genetic sources, 328 major histocompatibility complex, T-cell Histamine-methyl transferase (HMT) electrophysiology, epilepsy, 708 activation, 601 Hyperkalemic periodic paralysis, 790-791 nervous system regulation, 602-603 brain metabolism, 328 non-histaminergic nerve terminals, 328-329 Hyperornithinemia, 751 neuroimmunology, 599-601 polymorphisms and neurologic disorders, Hyperphosphorylation, tau protein, 835-836 lymphoid tissue innervation, 602-603 329 animal models, 838-841 neuropeptides, 603

Inner ear	protein sorting and glycosylation, Golgi	electrolyte imbalance and alteration of, 798
anatomy, 924f	complex, 129–130	gating mechanisms, 66, 67f
hair cells, 923	secretory cells, regulated pathway	macromolecular complexes, voltage-
Inositol lipids, 443-448, 444f	specialization, 133f, 134	dependent gating mechanisms,
D-myo-Inositol 1,4,5-trisphosphate,	secretory vesicle biogenesis, 134-135	67–68
calcium liberation, endoplasmic	trans-Golgi network, lysosomal protein	mechanical transduction activation,
reticululm, 448–449, 448f	sorting and targeting, 132	920–921
cell regulation, 451–453, 451f	trans-Golgi network, plasma membrane	membrane phospholipids, 644
Charco-Marie-Tooth disease, 445	protein sorting, 131–132	metabotropic glutamate receptor
ligand-activated hydrolysis, neural tissue,	coat protein removal, 124–125	modulation, 358–359
446t	dynamin proteins, vesicle and organelle	molecular basis, 71–75
phosphatase dephosphorylation, 445–446	targeting, 123–124	fast inactivation gate, 74–75, 75f
phosphatidylinositol 3-kinase synthesis,	endocytic pathway, 120, 135–139	selectivity filter and pore, 71–74, 73f
3'-phosphoinositides, 444	macromolecular degradation and	molecular signaling mechanisms, cell
phospholipase C isozyme cleavage, 446–	nutrient uptake, 135–137	surface receptors, 246–248
448, 446f, 447f	receptor-mediated endocytosis, 137–139,	mutations and genetic disease, 77
structure and metabolic function, 443–444,	138f	neurotransmitter receptor coupling, G
443f, 444f	G proteins, 415	proteins, 412–414
Inositol phosphates, 448–449	GTP-binding proteins, transport function,	nicotinic acetylcholine receptors, 269
D-myo-inositol 1,4,5-trisphosphate,	122–123	pharmacological agents in, 68–69
calcium liberation, 448–449, 448f	inositol lipids, 451–452	phosphoinositide regulation, 452–453
metabolism and free inositol regeneration,	mammalian cell mechanisms, 120–121, 121f	taste receptor interaction, 914
449, 449f	molecular events, 121–126	voltage-dependent gating mechanisms
myo-inositol cell presence, 449	SNARE and Rab proteins, target membrane recognition, 125	moving charges, 73f, 74
Insect venom, muscle excitation alteration, 796–798	synaptic vesicles, 139–144	protein component conformation, 68, 69f Ionotropic glutamate receptors
Inside-out signaling, integrins, cell adhesion	future research issues, 142, 143f	classification, 347–356, 349f
molecules, 172–173, 175f	neurotransmission exocytosis, 139–142	genetic knockout studies, 358
Insomnia, 995–996	presynaptic terminal organization,	permeation pathways, 48, 357f
Integrins, cell adhesion molecules, 170–175	secretion/recycling optimization,	subunits, 348–350, 350f
anti-integrin antibodies, multiple sclerosis	139, 140–141t	Ionotropic purinergic receptors, classification,
therapy, 174	transport vesicles	384
cadherin cross-talk, 177–178	budding, 65	Ionotropic transmission, histamine
extracellular matrix proteins, 170-172, 173f	cargo unloading, membrane fusion, 125	modification, 335
inside-out and outside-in signals, 172–173	Intracellular messengers	Ion potentials, mammalian skeletal muscle,
myelination regulation, 173-175	glutamate ionotropic/metabotropic	65t
Intercellular signaling	receptors, postsynaptic density,	Ion selectivity filter, 71–74, 73f
molecular signaling mechanisms, cell	360–361	Isaac syndrome, potassium ion channel
surface receptors, nitric oxide,	histamine H <sub>1</sub> receptor, 330–331	antibodies, 794–795
249–256	histamine H <sub>2</sub> receptor, 331	Ischemia
peptides, 392	histamine H <sub>3</sub> receptor, 333–334	acute ischemic stroke, therapeutic
Interleukin-10, neuroinflammation and, 614	histamine H <sub>4</sub> receptor, 335	protection, 638–640
Intermediate filaments (IFs), neuronal and	Intracellular pH, anion antiporters, 56	brain responses to, 621–623
glial morphologies, 106–108, 107f,	Intracellular signaling	calcium signaling and, 464
108t	anxiety disorders, 1033	excitotoxic glutamate neurotransmitter, 627
Interneuronal synapses, cell adhesion	axonal regeneration, neurite growth	focal cerebral, 622–623, 622f, 623f
molecules, cooperative regulation,	mediation, 589	free fatty acid release, 655–656
175–177, 176f, 177f	G protein second messenger regulation,	global cerebral, 623, 626f
Intracellular catalytic domains, receptor	414–415	lipid mediator pathways, platelet-
protein tyrosine phosphatases, 505	molecular signaling mechanisms, cell	activating factor, 651f, 652
Intracellular membrane trafficking	surface receptors, cross-talk, 249 mood disorders and, 1026–1030, 1028f	membrane lipid breakdown, 654–655
biosynthetic secretory pathway, 126–135	*	necrosis and, 672–673
compartments and transport sequence, 128f	neuropeptides, 393f schizophrenia, 1008	neuroinflammation, reperfusion damage and, 616
constitutive secretory pathway, 133f, 134	transmembrane domains, 29, 30f	neuroprotectin D1 inhibition, 657, 658f
COPII-coated vesicles, Golgi complex	Intracranial pressure, aminoacidurias and	phospholipase A <sub>2</sub> signaling, reperfusion
delivery, 127–129	brain edema, 742	and, 654, 655f
endoplasmic reticulum classification,	Intronic mutations, MAPT gene, 836–837	phospholipases A <sub>2</sub> , arachidonic/
126–127	Ion channelopathies, 77–78	docosahexaenoic acid release, 647
glycosylation compartmentalization, 127t	Ion channels	phospholipid targeting, synaptic
Golgi apparatus components, 129	action potentials, electrically excitable cells,	membranes, 645
Golgi cisternae protein/lipid transport,	66	potential therapeutic strategies, 638–640
cis to Trans direction, 130–131, 131f	backbone structure and topology, 77	stroke penumbra, 622–623, 624f, 625f, 626f
lysosomal pathway convergence, 132	cyclic GMP-gated ion channels, guanylyl	Isoprenoids
neuroendocrine secretion pathways,	cyclase receptors, 433	five-carbon branched chain, 82
132–133	diversity, 75–77	hydrophobic lipids, 82

1079

lipoxygenases, 653

neuroinflammation, 616

Isozymes, adenylyl cyclase, expression and Large dense-core vesicles (LDCVs), neural membrane phospholipids, 644-647 neuropeptide packing, 399, 400f cyclooxygenases, 652-653 regulation, 324 Lateral geniculate nucleus, nervous system diacylglycerol kinases, 654 development, 543 docosahexaenoic acid, 656-657 Juxtacrine effects, neuropeptide receptors, 402 L-DOPA docosanoids, 657 Juxtaparanodal proteins, myelin sheath, 195 aromatic amino acid decarboxylase eicosanoids, 648-649, 648f, 649f, 650f conversion to dopamine, 285-286 lipid peroxidation and oxidative stress, K tyrosine hydroxylase regulation, 284-285, 657 Kainate (KA) receptor lipoxygenases, 653-654 flip/flop variants, 354-356, 355f Learning messenger function, 645 adenylyl cyclase cAMP targeting, 430 identification, 347-356 neuroinflammation, 654-656, 655f quinoxalinedione blockage, 350 cGMP signaling, guanylyl cyclase neurolipidomic signaling, 657–660 Katanin, microtubule organization, 106 receptors, 434 neuroprotectin D1, 657, 658f α-Ketoglutarate, glutamate derivation, Doogie mice studies, 969-971, 969f, 970f phospholipase cleavage, 645 glutamatergic synapse potentiation/ 343-346, 344f phospholipases A<sub>2</sub>, 647-648 Ketone bodies, brain energy metabolism, depression, 346-347 platelet-activating factor, 649-652, 651f 219-220 molecular mechanisms of, 965-971 polyunsaturated fatty acyl chains, 645brain development and, 204-205 late-phase LTP expression, 967-968 646, 646f Kinesin-related proteins (KRPs) NMDA receptor and LTP induction, 966synaptic membrane targets, 645 axonal transport, 156-161 967, 967f translational neurosciences, 659 anterograde fast axonal transport, synaptic plasticity transmembrane ion gradients, 644 157-158 Hebb's rule, 965-966 neuroinflammation, 614-616, 615f biochemical properties, 157 hippocampus and, 966f lipoxin, resolvin, and neuroprotectin axonal transport and neurodegeneration, 161 long-term depression and receptorpathways, 616 KKXX retrieval signals, biosynthetic secretory independent LTP, 968 Lipid peroxidation, oxidative stress and, 657 pathway, COPII-coated vesicles, Lesch-Nyhan syndrome, 381 Lipid rafts endoplasmic reticulum delivery, Leucine-rich repeat kinase-2 (LRRK2), cell membrane function, 33-34 129 Parkinson's disease mutations, cytoskeleton interaction, 35-36, 36f Knock-down therapies, polyglutamine repeat 832-833 metabolopathies and, 778-779 diseases, 850-851 Leukocytes, CNS immune activity Knockout mice influx and efflux mechanisms, 604 amino acid disorders, myelin formation, axonal regeneration, nogo gene parenchyma migration, 604-605 development, 588 Leukodystrophies biosynthetic secretory pathway, Golgi catecholamine studies, 285t genetics, 699-701 cisternae transport, 130-131, 131f glutamate receptor genetics, 358 myelination and, 578 brain lipids, 82-83, 85f learning research, 969-971, 970f stem cell treatment, 564 biosynthesis, 90-96, 90f metabotropic glutamate receptor studies, 359 Leukotriene pathways chromatography and mass spectrometry analysis, 89-90 neuropeptide studies lipoxygenases, 653 enkephalin function, 405-406 normal adult, 91t neuroinflammation, 614-615 peptide-processing enzyme genes, Lewy body dementia, 833f complex lipids, 83-89 404-405, 405f genetics, 725-726 inositol lipids, 443-448, 444f prion protein analysis, 878-879 host-to-graft spreading pathology, 832f cell regulation, 451-453, 451f Krabbe disease, 699-701 α-synuclein and, 831-832, 831f Charco-Marie-Tooth disease, 445 Lifestyle factors, stress and, 951-953 ligand-activated hydrolysis, neural lysosomal mutations, 758, 758f Ligand-activated phosphoinositide stem cell therapy, 565 tissue, 446t K-Ras protein, lipid rafts and, 34 hydrolysis, 446t phosphatase dephosphorylation, 445-446 Krebs cycle, defects in, 776 Ligand-gated ion channels phosphatidylinositol 3-kinase synthesis, Kuru, prion proteins, 875 alcohol addiction and, 1049 3'-phosphoinositides, 444 GABA<sub>A</sub> receptors, 370, 370f, 371f, 372t phospholipase C isozyme cleavage, L 446-448, 446f, 447f three-dimensional structure, 374-375 Lactate, brain energy metabolism, 211-215 structure and metabolic function, 443nicotinic acetylcholine receptors, 269 astrocyte-neuron lactate shuttle, 215 cys-loop channels, 268f 444, 443f, 444f complex compartmentation, 214 pentameric channels, 267-268, 268f muscular metabolic disorders, 763 conditions, 214-215 serotonin receptor subtypes, 318-319 myelin, central nervous system formation conditions, 211-214 enrichment, 186-187, 187t strychnine-sensitive chloride channel sorting and transport, 575-576 lactate-pyruvate interconversion, 211 receptors, glycine inhibition, peroxisomal diseases, 760-761 250-251 Lactate dehydrogenase (LDH) brain energy metabolism, lactate-pyruvate tyrosine phosphorylation, transmembrane in plasma membranes, endoplasmic interconversion, 211 topology, 510f reticulum and Golgi membranes, glycolytic defects, 764-766 Ligand-operated channels (LOC), calcium Lafora disease, 771 synuclein lipid-binding proteins, 830 ions, 457f Lipid solubility, blood-brain barrier Lambert-Eaton syndrome, calcium channel Light microscopy, myelin ultrastructure, antibodies, 794 permability and, 21-22 181-184, 182f Large dense-core vesicle (LDCV), peptide Linear acceleration, vestibular organs, Lipoxin pathway

923-925

Lipid mediator pathways

release, 393

neuronal expression, 393-394

Lipoxygenases	cytosol-mitochondrial transfer, 210–211	Membrane proteins, 28–29
arachidonic acid conversion, 648-649, 648f,	metabolic pathway linkage, 211	axonal transport, fast transport, 150f,
649f	Malate dehydrogenase, brain energy	151–152, 151f, 152f
arachidonic acid substrate, 649	metabolism, tricarboxylic acid	cytoskeleton interaction, 34
ischemia-reperfusion process and	cycle, 217	Golgi complex sorting and glycosylation,
accumulation of, 656	Malignant hyperthermia	biosynthetic secretory pathway,
lipid mediator pathways, 653-654	calcium ion channel mutations, 793	129–130
Long-chain aminodiol sphingosine backbone,	ryanodine receptor mutation, calcium	lipid bilayer fluidity, 29–31
sphingolipids, 85–89, 89f	release channel, 792–793	primary active transport (P-type) pumps,
Long-chain carboxylic structure, fatty acids,	Maple syrup urine disease, 742–743	41–42, 41f
82–83, 83f	MAPT gene	protein-lipid binding, 29
Long-chain fatty acids, G protein	tauopathies and mutations of, 836–837	transmembrane domains, 28–29, 29f
modification, 418	tau protein isoforms, 834–835, 835f	Membrane signaling. <i>See also</i> Intracellular
Long-term depression (LTD), synaptic	Mass spectrometry, brain lipids, 89–90	membrane trafficking
plasticity and, 968	Mast cells	lipid rafts and, 33–34
Long-term memory, 965	functions, 324	Membrane vesicle trafficking, Rab proteins,
Long-term potentiation (LTP)	histamine function, 324	419, 419f
glutamatergic synapses, learning and, 346–347	histamine storage and release, 324	Memory consolidation, 965
	McArdle disease, 763	episodic cell assemblies, 975–977
induction mechanism, 966	MDMA (Ecstasy), serotonin transporter and,	molecular mechanisms, 971
molecular mechanisms, 967–968	307	Memory function
NMDA receptor and, 966–967	Mechanoreceptors, organisms and cell types,	adenylyl cyclase cAMP targeting, 430
tyrosine phosphorylation, 509–511	916–917	cGMP signaling, guanylyl cyclase
Low-threshold calcium current, epilepsy	Mechanotransduction	receptors, 434
antiseizure drugs, 712, 712f	balance, 916–917	declarative vs. procedural memory, 965
Lymphoid tissue innervation, innate and	vesibular organs, 923–926	differential reactivations, episodic cell
adaptive immunity, 602–603	deafness genes, 922	assemblies, 975–977
Lymphoreticular system, prion disease	hair cells, 918–923, 919f, 920f	fear memory recall
pathology, 876	cochlear cells, 926	hippocampal concept cells, 976f
Lysinuric protein intolerance, 751	inner ear, 923	multiple-discriminant analysis, 977f
Lysosomal proteins, biosynthetic secretory	stereocilia actin, 921–923	hippocampal concept cells, nest cells and
pathway	hearing, 916–917	Halle Berry cells, 975, 979f
intracellular trafficking, pathway	cochlea, 923	hippocampal function, 977–978
convergence, 132	cochlear hair cells, 926	imagination, 978–979
trans-Golgi network sorting, 132	high-frequency sound detection, 925-926	hippocampal neuronal pathways, 347, 348f
Lysosomal storage diseases, 699–701,	inner ear anatomy, 924f	molecular mechanisms, consolidation and
756–757t	prestin electromotility, 925f	storage, 971
Fabry disease, 759	ion channel activation, 920-921	network-level real-time memory traces, 974
Farber disease, 757	molecular mechanisms, 921	neural cliques
Gaucher disease, 757–758	non-vertebrate model system, 917-918, 917f	categorical/hierarchical organization,
G <sub>M2</sub> gangliosidoses, 759–760	Medial temporal lobe epilepsy (MTLE), 709	978f
Krabbe disease, 758, 758f	Megaloblastic anemia, hereditary folate	general-to-specific feature-encoding,
lysosomal enzyme deficiency, 756–757	malabsorption, 749	974–975
metachromatic leukodystrophy, 758–759	Melatonin, autism spectrum disorders, 1016	real-time memory coding, 974
mucopolysaccharidoses, 760	Membrane-associated polysomes,	neural coding, 971–974
neuronal ceroid lipofuscinoses, 760	biosynthetic secretory pathway,	neural population-level memory traces,
Niemann-Pick disease A/B, 760	endoplasmic reticulum	971–979
Niemann-Pick disease C, 760	membrane, 126–127	NR2B targeting, 972–973
organelle function, 755–756	Membrane-bound organelles (MBOs)	Penfield studies, 964
pleiotropic mutations, 757–760	axonal transport, molecular motors, 158	protein phosphorylation, 479t, 484–489
prognosis, 757	fast axonal transport	research background, 963–965
progressis, 757	molecular sorting, protein distribution to	short-term vs. long-term memory, 965
M	membrane components, 154–155	
	<u> </u>	temporal lobe system, 964–965, 964f
Macromolecular degradation, endocytic	pharmacological studies, 152f, 153	Mental retardation, G proteins and, 420
pathway, 135–137	retrograde transport, 153–154	Mesocorticolimbic system, addiction and
Macrophages, CNS immune activity, 605–606	video images, 151	dopamine transmission, 1040f,
Magnetic resonance spectroscopy, brain	Membrane cytoskeleton, neuronal and glial	1042f
energy metabolism, 222–223, 224f,	morphologies, 108–110	Metabolic crisis, neonatal, urea cycle defects,
225f	Membrane fusion, intracellular membrane	750–751
Major histocompatibility complex	trafficking, transport vesicle cargo	Metabolic stress, apoptosis activation, 668
neuroinflammation, microglia activation,	unloading, 125	Metabolism
612	Membrane lipids, amphiphilic molecules, 82	blood-brain barrier solute carriers and, 22
T-cell activation, neuroimmunology,	Membrane potential	myelin metabolic turnover, 577
599–601	excitable cells, negative potential, 64–65,	Metabotropic glutamate receptors
Malate-aspartate shuttle, brain energy	64f	classification, 347, 349f, 358
metabolism, 210–211, 214f	transport system production, 65	cytoplasmic signaling enzymes, 358

diacylglycerol kinases, 654	apoptosis activation and changes in, 670,	myosins, 160
genetic knockout studies, 359	671f	peripheral neuropathies and, 688
ion channel modulation, 358–359	brain energy metabolism	Molecular signaling mechanisms
presynaptic activation and inhibition, 359	assays, 226	cell-surface receptors, 246–249, 246f,
synaptic transmission, 358–359	glutamate-glutamine metabolism, amino	247t
Metachromatic leukodystrophy, 699–701	acid transport, 220	first group, 246–248
lysosomal mutations, 758–759	glycolysis regulation, 208–209	fourth group, 248–249
stem cell therapy, 565	heterogeneity, neural and glial	second group, 248
Metalloproteinases, neurovascular unit	mitochondria, 219–220	third group, 248
disruption, 631–632	malate-aspartate shuttle, cytosol transfer,	tau protein scaffolds, 840
Methionine, homocystinuria and	210–211	Molecular sorting mechanisms, fast axonal
homocysteine remethylation, 748	malate dehydrogenase, 217	transport, 154–155
Methionine synthase, homocystinuria and	partial TCA, 219	Monoamine oxidase (MAO)
deficiency of, 748	substrates, 219–220	catecholamine metabolism, 290–291, 291f
Microautophagy, endocytic pathway, 136	tricarboxylic acid cycle, astrocytes and	serotonin catabolic pathway, 310–311
Microdomain signaling, calcium ion	neurons, 219	Monoamines
channels, 461	and calcium ion channels, 460–461, 460f	catecholamines, 283
Microfilaments (MFs)		
, ,	central nervous system distribution, 219	cocaine and amphetamine addiction, 1044
associated proteins, 109t	diseases	sleep regulation, 986–987
eukaryotic cytoskeleton, 102, 102f, 103f	substrate utililzation defects, 775–776	depression and, 987
growth cone motility and, 112	transport defects, 775	Monocarboxylic acid transporter (MCT),
Microglia	DNA, maternal inheritance, 773	brain energy metabolism,
CNS immune activity, 605–606	ischemia-reperfusion injury, 631	transporters, glucose/
phenotype, 606–607	metabolism cycle, 769f	monocarboxylic acid uptake,
components of, 11–15	genetic mitochondrial diseases, 774-775	203–204, 204f
immune-competent microglia, brain	nDNA-mtDNA communication	Monogenic disorders, nicotinic acetylcholine
development and, 23	defects, 775	receptors, 272
injury response, 386, 386f	metabolic dysfunction, 772–779, 774t	Monomeric GTPases, intracellular membrane
neuroinflammation and, 611-612, 611f	mitochondrial DNA and, 775–779	transport, 122–123
aging and, 613	mtDNA biochemistry, 775–779	Monomer structures, polyglutamine protein
cytokine production, 614	neuroinflammation and, 617	misfolding, 846
homeostasis disruption, 618	neuron morphology, 8-9	Mood disorders
neurodegenerative disease, 613	Mitochondrial DNA (mtDNA)	cGMP signaling, guanylyl cyclase
phagocytosis, 612	biochemical classification, 775–779	receptors, 434
protein aggregation and, 614	genetic translation defects, 775	epidemiology, 1021, 1022
receptors, 612–613	maternal inheritance, 773	future research and therapies, 1033–1034
phagocytosis and inflammatory process	mutations and disease, 774t	intracellular signaling pathways,
and, 15–16, 15f	nuclear DNA, communication defects, 775	1026–1030, 1028f
Microinjection techniques, learning research,	Mitogen-activated protein kinase (MAPK)	neuroanatomical and neuropathological
mouse models, 970f	pathway	correlates, 1025–1026
Microinterfering RNA, neurodegenerative	G protein subunit regulation, 415–416	neurotransmitters and neuropeptide
disease epigenetics, 731–733	protein Ser/Thr kinase signaling, 476–478,	systems, 1022–1025
Microtubule-associated proteins (MAPs),	476f	brain growth factors, 1025
105–106	Molecular biology	cholinergic system, 1024
Microtubule organizing center (MTOC), 103	neuropeptide receptors, drug targeting,	cortical-hypothalamic-pituitary-adrenal
	402	axis, 1024
Microtubule plus-end tracking proteins		
( + TIPs), microtubule	schizophrenia, 1004–1009	dopaminergic system, 1024
organization, 106	serotonin receptor subtypes, 314	GABAergic system, 1024
Microtubules (MT)	Molecular cloning, muscarinic cholinergic	glutamatergic system, 1024
cytoskeletal proteins, 105t	receptors, 275–276, 275f	neuropeptides, 1025
eukaryotic cytoskeleton, 102, 102f	Molecular geometry, bilayered lamellar	noradrenergic system, 1023
growth and regeneration, slow axonal	structures, amphipathic	serotonergic system, 1022–1023
transport, 155–156	molecules, 27–28	substance P, 1025
growth cone motility, 112	Molecular mechanisms	thyroid axis, 1024–1025
structure and organelle tracking, 102–106,	learning, 965–971	Motility, cytoskeleton growth cone, 110f
103f, 104f, 105t, 107f	pain management, 934	Motor neurons
tau protein association, 834–835	slow axonal transport, 156	diseases. See also specific diseases
Mild cognitive impairment, Alzheimer's	Molecular mimicry, Guillain-Barré syndrome,	amyotrophic lateral sclerosis, 801–806
disease diagnosis, 816	686f	axon communication disruption, 806
Mineralocorticoid receptors, transcription	Molecular motors	genetic models, 806–809
factors, 521–524, 523f	axonal transport, 156–161	mouse models, 809–811
Miniature endplate potentials (MEPPs),	biochemical properties, 157	superoxide dismutase and redox
synaptic transmission exocytosis,	cytoplasmic dyneins, 159–160	signaling, 810
239, 242f	function matching, 160–161	nerve injury models, 806
Mitochondria	kinesins, 157–159	neuromuscular junction, muscle cells,
anterograde fast axonal transport, 153	membrane-bound organelles, 158	543

Mouse genetics	organization, 783–786, 784f	biochemical changes, 692
amyotrophic lateral sclerosis, phenotype	Muscle diseases	classification, 692
development, 807–808	carbohydrate and fatty acid metabolic	developmental insults, nutritional
epilepsy genetics and, 713–717, 713t, 714t	dysfunction, 763–768	deficiency, and toxins, 701–702
spontaneous and engineered mutations,	excitability disorders, 789t	genetically-determined disorders,
mouse studies, 715–717, 715–716t	acetylchonine synthesis, 785	699–701, 700t
GABA <sub>A</sub> receptor subtypes, 375	elecrolyte imbalances, 798	neurochemistry, 693
learning and memory research, 969-971	immune diseases, 793–795	neuronal disorders, 703
motor neuron disease therapies, 809-811	neuromuscular junction, 783-786, 784f	peripheral neuropathies, 697–699
synucleinopathies, 833-834	toxins and metabolites, 795-799	repair mechanisms, 702–703
Movement control, basal ganglia and, 857	hereditary diseases, 790-793	integrin regulation, 173–175
MsbA ATP-binding cassette transporter,	Brody disease, 793	maintenance, 577–579
three-dimensional structure,	calcium channel mutations, 791, 792–793	nervous system development and function,
50–51, 51f	chloride channel mutations, 792	570
Mucopolysaccharidoses (MPS), 760	potassium channel mutations, 791	oligodendrocytes, central nervous system,
Multidrug resistance (MDR) proteins,	ribonuclear inclusions, 791–792	13, 570, 573f
amphipathic molecule flipping, 52	ryanodine receptor calcium release	periventricular leukomalacia, 579
Multiphoton confocal analysis,	channels, 792–793	Schwann cells, peripheral nervous system,
neurolipodomic signaling, 660	sodium channel mutations, 790–791	13–15, 14f, 570, 571f, 572f
Multiple-discriminant analysis, real-time	mitochondrial dysfunction in, 772–773	spinal cord injury, fiber growth and
memory coding, 977f	Muscle relaxants, nicotinic acetylcholine	regeneration, 592
Multiple sclerosis	receptor targeting, 273	stem cell replacement therapy, 564–565
animal models, 696–697	Muscle-specific kinase (MuSK)	synthesis and deposition, 575
anti-integrin antibodies, 174	myasthenia gravis mimicking, 793–794	ultrastructure, 181–184, 182f, 183f
axonal and neuronal pathology, 694	neuromuscular junction development,	nodes of Ranvier, 182–183, 184f, 186f
biochemistry, 694–695, 695f	798–799	Schmidt-Lanterman clefts, 185
demyelination, 692–696	tyrosine phosphorylation, 509	Myelin-associated glycoprotein (MAG)
diagnosis, 692–693	Myalgia, phosphorylase deficiency, 763	central nervous system myelin, 191–192
environmental factors, 695–696	Myasthenia gravis, 793, 794f	CNS/PNS myelin, 193–194
epidemiology and natural history, 695	Myelin	immunoglobulin-cellular adhesion
etiology, 695	amino acid disorders, reduction of, 742	molecules, 167
future research, 696	assembly, lipid/protein sorting and	Myelin-associated oligodendrocytic basic
genetics, 696	transport, 575–576	protein, myelin composition, 197
gray matter lesions, 693–694, 694f	axonal cytoskeleton organization and loss	Myelination
immunology, 696	of, 113–114	genetic disorders, 576–577
pathology, 693	axonal regeneration, growth inhibition	rodent mutants, 576–577, 577t
remyelination, 702	activity, 588–589	nervous system development and function,
stem cell immunomodulation, 566	axonal structure, 185	570
therapy, 695	Canavan's disease and, 753	regulation, 574–575, 575f
viral models, 696	cell membrane extension, 184–185	remyelination, 579–580
Multiple system atrophy (MSA), 833, 833f	central nervous system, neurite growth	SLC25A12 gene mutation,
Multipotent stem cells, 558–559	inhibition, 585–586	N-acetylaspartate formation and
Multivesicular bodies (MVBs), endocytic	composition, 185–197	brain function, 212–213, 212f
pathway, clathrin-coat-dependent	central nervous system proteins in,	Myelin basic protein (MBP)
process, 139	188–192, 188f	central nervous system myelin, 188, 189-
Muscarinic cholinergic receptors, 274–280	2':3'-cyclic nucleotide	190, 190f
G-protein-coupled receptor mediation, 274	3'-phosphodiesterase, 190-191	CNS/PNS myelin, 193
molecular cloning, 275-276, 275f	developmental changes, 576	Myelin/oligodendrocyte-specific protein
muscarine mimicking, 274	lipid enrichment, 186–187, 187t	(MOSP), myelin composition, 197
neuropsychiatric disorders, central nervous	myelin-associated glycoprotein, 191–194	Myelin protein zero, peripheral neuropathies,
system distribution, 277	myelin basic proteins, 189–190, 190f, 193	682
peripheral tissure physiology, 274t	P <sub>0</sub> glycprotein, 192	Myelin sheath
pharmacological therapies, cholinergic	P <sub>2</sub> protein, 193	axon function and, 578
disorder, 278	peripheral and central nervous system	protein content, 194–197
subtype distribution, 277	myelin, 187–188	enzymes, 195–197
subtype-G-protein coupling, 276, 276f	peripheral myelin protein-22, 192–193	miscellaneous proteins, 197
subtypes, pharmacological analysis, 274–275	peripheral nervous system proteins,	neurotransmitter receptors, 197
synaptic terminal, choline accumulation,	192–193	nodal, paranodal, and juxtaparanodal
260–261, 261f	proteolipid protein, 188–189	proteins, 195
transgenic studies, <i>in vivo</i> subtype	subcellular fractionation yield and	tetraspan proteins, 194–195
assessment, 277–278	purity, 185–186, 187f	signal transduction, 577–578
Muscle cells	conduction functions, 180–181, 181f	structure and properties, 180–185
	diseases	* *
fiber excitation and contraction, 788f		Wallerian degeneration, peripheral nervous
calcium coupling, 787–789, 788f neuromuscular junction	acquired immune-mediated and/or infectious disease, 692–699	system, 583 Myoadenylate deaminase (MADA), Lesch-
motor neurons, 543	animal models, 696–697	Nyhan syndrome, 381

Myocytes, structure and function, 786-787, reelin and notch signaling, cortical layer frontotemporal dementia, 726-727, 726t, organization, 539, 539f 787f 727t Myofibrils, structure and function, 786-787, peripheral nervous system, target Huntington's disease, 729-730 787f, 788f interaction, 541-542, 542f Lewy body dementia, 725-726 sensory experience and motor activity, Myoglobinuria mutation and polymorphism clinical manifestations, 766 543-544 identification, 721t phosphorylase deficiency, 763 spatial regionalization, 534-539 Parkinson's disease, 722t, 723-725, 723t, Myoinositol dorsoventral pattern, 534-535, 536f 724t facilitated diffusion, 58-60 rostrocaudal axis, 535-538, 537f triplet repeat disorders, 729-730 urea cycle defects, cognitive function and, synapse formation, 543, 544f hereditary folate malabsorption, 749 tuberous sclerosis, 540 immune-mediated disorders, 598 Myo-inositol, phosphorylated forms, 449 Nest cells, memory function, 975 microglia, 611-612, 611f, 613 Myosin, axonal transport Network-level real-time memory research, 974 disease sensors, 618 biochemical properties, 157 Neural cell adhesion molecules (NCAM) mitochondria, neuroinflammation and, 617 neuronal function, 160 intracellular signaling, 29 phospholipid targeting, synaptic Myotonia, congenital, 792 structure and properties, 167-168, 168f, 170f membranes, 645 Myotonic dystrophy, ribonuclear inclusions, Neural cliques prion-mediated mechanisms, 883 791-792 general-to-specific feature-encoding retina, 899-900 assemblies, 974-975, 978f molecule-directed therapies, 900 real-time memory coding, 974, 976f, 977f, Neurodevelopmental disorders, myelin N-acetylaspartate (NAA), SLC25A12 gene formation and stability, 701-702 mutation, formation of, 212-213, Neural crest, peripheral nervous system Neuroendocrine secretion development, 541-542, 542f biosynthetic secretion pathway, 132–133 N-acetyl aspartate metabolic disorders, 753 stem cells, 560-561, 561f serotonin modulation, 312 N-acetylglutamate synthetase deficiency, 750 Neural function, P-type copper transporters, 50 synaptic transmission, regulated secretory Narcolepsy Neural markers, 562t pathway, 245 GABAergic neurotransmission, 991 Neural population-level memory traces, Neuroepithelium, olfactory system, 905, 905f histamine and, 338 971-979 Neurofibrillary tangles, Alzheimer's disease, Neural stem cells, neuron and glial 818-819 hypocretins and, 990 Natriuretic peptides, guanylyl cyclase development, 559-561 Neurofibromatosis type 1 (NF1), G proteins Neural tube, central nervous system receptors, 432 and, 420 development, 534-539, 535f Neurofilaments (NFs) Necrosis cortical neuron layers, 538-539, 538f disruption, neuropathology and, 115-116 basic features, 665f caspase substrates, 664t Neuregulins, basic properties, 555 eukaryotic cytoskeleton, 102, 102f cell disintegration, 672 Neurexin-neuroligin interactions, cell growth and regeneration, slow axonal cell morphology and biochemistry, 664 adhesion molecules, synapse transport, 155-156 embryonic and postnatal development, regulation, 176, 177f motor neuron disease models, 807 neuronal and glial morphologies, 108 663-664 Neurites energy failure/ischemia, 672-673 Alzheimer's disease pathology and, 818 Neurogenesis neurological disease and, 673-675 antibody-mediated neutralization, spinal brain function and stress and, 959-960 cord injury, 592 hippocampal stress and, 949 trauma, 672 Negative feedback, olfactory transduction, axonal regeneration nervous system development, 539-541 neuronal birthdate, 539 908-909 Nogo-A neuronal expression, 589 Neonatal brain damage proneural gene functions, 540-541 Nogo-A protein inhibition, 586 compensatory plasticity and, 590 surface receptors and intracellular reelin and notch signaling, cortical layer metabolic crisis, urea cycle defects, 750-751 signaling molecules, 589 organization, 539, 539f Nernst equation, membrane potential, 65 cadherin-integrin cross-talk, 177-178 Neuroimmunology Nerve growth factor (NGF) Neuritic plaques, Alzheimer's disease, 818 central nervous system, 603-607 blood-brain barrier and leukocyte axon-based nervous system development, Neurochemicals anxiety disorders, 1030-1033 influx/efflux, 604 542-543 basic properties, 547-548 autism spectrum disorders, 1013, 1014-1016 leukocyte migration, 604-605 identification, 547-551, 547f, 548f stem cell replacement, Parkinson's disease, microglia function, 605–606 pain management, 549 563-564 microglia phenotyping, 606-607 Nerve injury Neurodegenerative disease. See also defined, 597 immune response, 938-939 immune-mediated neurodegenerative Neurological disease. specific diseases motor neuron disease model, 806 disorders, 598 pain management, 936-939, 937f adenylyl cyclase targeting, 430 immune responses and neurologic Nervous system development apoptosis, 667-668, 667f outcomes, 607 axon guidance, 542-543 cardiolipin, 81, 86f, 87f immune tolerance and inflammation, 601-602 naturally occurring cell death, 542-543 genetics innate vs. adaptive immunity, 599-601 Alzheimer's disease, 721-723, 721t embryology, 534 lymphoid tissue innervation, 602-603 embryonic signaling, 538-539, 539f amyotrophic lateral sclerosis, 727-729, 728t neuropeptides, 603 manipulation, 608 myelination and, 570 Creutzfeld-Jakob and other prion neurogenesis and gliogenesis, 539-541 diseases, 730-731 neuronal function and mammalian neuronal birthdate, 539 epidemiology, 719-721 behavior, 607-608 proneural gene functions, 540-541 epigenetic modifications, 731-733 Toxoplasma gondii, 598-599

Neuroinflammation	signal transmission, 785–786, 785f	mitochondrial heterogeneity in, 219-220
CNS immune system and, 616–617	synapse formation, 543, 544f	neurogenic development, 539
-	* *	
cytokines/chemokines, 613–614 defined, 610–612	synaptic transmission, 238–239, 240–241f calcium ion channels, 239–241, 243f	proneural and neurogenic gene
depression and, 1034	toxin and metabolite targeting of, 796–798	junctions, 540–541 neuropeptides in, 393–394, 393f
ischemia-reperfusion damage, 616	Neuromuscular synapse, tyrosine	nicotinic acetylcholine receptor family,
lipid mediator pathways, 614–616, 615f	phosphorylation, 509	269–270, 270f
lipoxin, resolvin, and neuroprotectin	Neuromyotonia, Isaac syndrome, 794–795	brain function and, 271
pathways, 616	Neuronal autoimmune encephalitis,	norepinephrine metabolism to epinephrine,
lipid signaling, 654–656	glutamate and, 353	288
lipoxygenases, 654	Neuronal β-tubulin isotypes	pain management, 936
microglia and, 611–612, 611f	microtubule organization, 105	phosphoprotein function, phosphorylation,
aging and, 613	β-III tubulin mutations, 115	482–483
cytokine production, 614	Neuronal ceroid lipofuscinoses (NCLs), 760	phosphoprotein regulation, 483, 483f
homeostasis disruption, 618	Neuronal development	prostaglandin release, 648–649, 650f
neurodegenerative disease, 613	astrocytic cholesterol synthesis, 32–33, 33f	protein kinase/phosphatase function,
phagocytosis, 612	cytoskeleton molecular components, 102–110	481–482
protein aggregation and, 614	actin microfilaments, neuronal growth	retinal sublayers, 890, 891f
receptors, 612–613	and secretion, 108–110	secretory cells, regulated secretory
mitochondria, neurodegeneration and, 617	eukaryotic cell definition, 102, 102f	pathway, 133f, 134
neuroprotection pathway, apoptotic	micofilament proteins, 109t, 110f	secretory vesicle biogenesis, 134
signaling, 633–635, 634f, 635f	microtubules, structure and organelle	serotonergic neurons, 301–304
neuroprotective signaling circuits, 617–618	tracking, 102–106, 103f, 104f, 105t	structural morphology, 6–9, 6f, 7f
protein aggregation and, 613–614	neuronal and glial intermediate	schizophrenia, 1008
Neurolipodomic signaling	filaments, morphology support,	ultrastructure and molecular organization,
future research, 657–660	106–108, 107f	110–112
translation neuroscience, 659, 659f	sodium-dependent D-glucose symporter, 52	axonal and dendritic cytoskeletons, 111–112
Neurological disease. See also	tyrosine phosphorylation, 505–508, 508f	cytoskeleton functions, 110–111
Neurodegenerative disease	Neuronal disorders, myelin involvement, 703	Neuropathology
apoptosis and necrosis, 673–675	Neuronal inhibition, opioid receptor	brain energy metabolism
glutamate receptor activation, 363–365	mediation, 1041	blood-brain barrier alteration, 204
glycinergic neurotransmission, 250–255	Neuronal primary cilium, Bardet-Biedl	imaging studies, 226
glycine biochemistry and transport, 250	Syndrome, 23	cytoskeletons
glycine receptor distribution, 252–253	Neuronal signals	alterations as hallmarks of, 114–116
glycine receptor structure and function,	addiction and, 1038–1041	protein phosphorylation, 116
251–252	extitatory/inhibitory, brain energy	mood disorders, 1025–1026
H <sup>+</sup> -dependent vesicular transporter, 250	metabolism, 205–206	axonal transport and, 161
ligand-gated chloride channel, glycine	peptide-based plurichemical coding, 403	pain management, 936–939
inhibition, 250–251	Neuronal specific enolase (NSE), brain energy	phospholipid targeting, synaptic
postsynaptic effects and pharmacology,	metabolism, 207	membranes, 645
250–251	Neurons	protein phosphorylation and, 490–491
postsynaptic gene mutations, 253–254	acetyl coenzyme formation, 218–219	tau protein, 836
presynaptic glycine transporter 2	alcohol addiction and, 1049	Neuropeptide receptors
mutation, 254	basic components, 4–11, 5f	amiloride-sensitive FMRF-amide-gated
startle disease molecular genetics, 253	brain energy metabolism, subcellular	sodium ion channel, 402
G proteins and, 420, 421	compartmentation, 225–226	distribution, 401–402
histamine functions and, 337	cholinergic neurons, central nervous	molecular drug targeting, 402
$H_3$ receptors, 337–339	system distribution, 262	peptide correspondence and, 402
histamine-methyl transferase	cyclic nucleotide spatiotemporal	seven-transmembrane-domain, G-protein
polymorphisms, 329	integration, 438–439	coupling, 400–401, 401f
immune functions and, 607	development, neural stem cells, 559-561	Neuropeptides. See also Peptides
nicotinic acetylcholine receptors, 272–273	disordered synchronous firings, epilepsy,	antigen-presenting cell modulation, 603
peptides in, 404–406	706t	anxiety disorders, 1032–1033
purinergic receptors, 387–388	enzymes in, 207t	appetite regulation and obesity, 405
tubulation mutations, 115	epilepsy, firing regulation, anti-seizure	basic properties, 392–393, 392f
Neuromuscular disorders	drugs, 711, 711f	biosynthesis, 394, 394f, 395f
carbohydrate and fatty acid metabolic	excitation mechanisms, 64f	classification, 390–391
dysfunction, 763–768	glutamine transfer from astrocytes, 362	dense-core vesicles, 399, 400f
mutant dynamin 2, 123	histaminergic	enkephalin knockout mice studies, 405–406
Neuromuscular junction	histamine storage and release, 328	mood disorders, 1022–1025
acetylchonine synthesis, 785	morphological and membrane	brain growth factors, 1025
development, muscle-specific kinase and,	properties, 325	cholinergic system, 1024
798–799	neurotransmitter connections, 335-336,	cortical-hypothalamic-pituitary-adrenal
genetic disorders, 789–790	336f	axis, 1024
congenital myasthenic syndromes, 789–790	immune-related changes, 607-608	dopaminergic system, 1024
organization, 783–786, 784f	intracellular membrane trafficking, 120	GABAergic system, 1024

glutamatergic system, 1024	Neurotransmitters	sleep regulation and wakefulness, 984,
neuropeptides, 1025	Alzheimer's disease damage to, 817–818	985f, 986–987
noradrenergic system, 1023	aminoacidurias and deficits in, 742	synaptic transmission
serotonergic system, 1022–1023	aspartate, 346	replenishment, fast transmission, 245
substance P, 1025	in basal ganglia, 857–860	secretory release, eukaryotic cells, 237–238
thyroid axis, 1024–1025	acetylcholine, 858	synaptic vesicle trafficking, 142, 143f
in neurons, 393–394, 393f	dopamine, 859–860, 859f	uptake and storage physiology, 55
pain perception, 406	dopamine-acetylcholine balance, 860	Neurotransmitter sodium symporters (NSS)
peptidergic neurons, 402–403	GABA, 857, 858f	subfamilies, 52
plurichemical neuronal signal coding, 403	glutamate, 858	synaptic clefts, neurotransmitter recovery,
regulation, 403–404, 404f	multiple systems, 860	52, 53f
signaling function, 403	GABA, 375	Neurotrophic cytokines, 555–556
Neuropeptides, novel compounds, 391f	glutamate, 343	Neurotrophic factor hypothesis, 547–551, 547f
Neuropeptide Y	histamine, 335	Neurotrophic factors
anxiety disorders, 1032	mood disorders, 1022–1025	apoptosis, 668, 670–671
derivation, 392f, 392–393 identification, 392	brain growth factors, 1025	axonal growth, 590
	cholinergic system, 1024	Neurotrophin 4, basic properties, 550
plurichemical coding, neuronal signals, 403	cortical-hypothalamic-pituitary-adrenal	Neurotrophin 4, basic properties, 550–551
structure and properties, 396–397, 396f	axis, 1024 dopaminergic system, 1024	Neurotrophin receptors, 548f, 551–553 p75 neurotrophin receptor, 552–553, 553f
Neuroplasticity, mood disorders and, 1026	GABAergic system, 1024	Trk receptors, 552, 552f
Neuroprotectin D1,	glutamatergic system, 1024	Neurotrophins, 547–551, 547f, 548f
ischemia-reperfusion inhibitor, 657	neuropeptides, 1025	brain-derived neurotrophic factor, 548–550
lipid mediation, 657	noradrenergic system, 1023	epileptogenesis, 710–711
Neuroprotection pathway	serotonergic system, 1022–1023	nerve growth factor, 547–548
neuroinflammation, 616	substance P, 1025	neurotrophin 3, 550
apoptotic signaling, 633–635, 634f, 635f	thyroid axis, 1024–1025	neurotrophin 4, 550–551
inflammatory mediators and anti-	neuropeptides vs., 392, 392f, 394f	proneurotrophins, 551, 551f
inflammatory regulation, 632–633	Rab protein release, 419, 419f	regulation, 551
Parkinson's disease treatment, 864–865	serotonin	Neurovascular unit
phospholipases A <sub>2</sub> , ischemia-reperfusion	amino acid L-tryptophan precursor,	brain injury and breakdown of, 631–632,
signaling, 654	304–306, 305f	632f
Neuroprotective signaling circuits	behavioral arousal/activity, 311–312	aquaporins, 632
mood disorders and, 1029	chemical structure, 301f	metalloproteinases, 631–632
neuroinflammation and, 617–618	circadian rhythm modulation, 312	cerebral capillaries, 18
Neuropsychiatric disorders	feeding behavior and food intake,	components, 19, 19f
basal ganglia involvement, 867–868	312–313	Neutral lipid storage disease, 768
cGMP signaling, guanylyl cyclase	indolealkylamine 5-hydroxytryptamine	NextGen sequencing, transcription factors,
receptors, 434	identification, 301	520–521
muscarinic cholinergic receptors, 277	monoamine oxidase oxidative	NF gene mutations, transgenic mice studies,
schizophrenia	deamination, catabolic pathway	808
brain imaging, 1003–1004	regulation, 310–311	NFκB, neuroprotectin D1 inhibition, 657
cellular and molecular studies, 1004-1009,	neuroanatomical organization, 301-304,	Nicotine addiction, 1048–1049
1006f	302f, 302t, 303f, 304f	nicotinic acetylcholine receptor targeting,
clinical aspects, 1000–1003	neuroendocrine function, 312	273
genetics, 1009–1010	receptors, 313–321	Nicotinic acetylcholine receptor agonist,
serotonin effects, 301–304	5-HT <sub>1P</sub> receptor, 320–321	nicotine addiction, 1048
Neuroscience, cellular neuroscience, 4	5-HT <sub>1</sub> subfamily, 314–317, 315t	Nicotinic acetylcholine receptor
Neurosphere functional assay, 561, 562f	5-HT <sub>2</sub> subfamily, 317–318	polymorphisms, 272
Neurosteroids, GABA <sub>A</sub> receptor function, 374	5-HT <sub>3</sub> receptor, as ligand-gated ion	Nicotinic acetylcholine receptors (nAChRs),
Neurotensin, neuropeptide receptors, 400–401	channel, 318–319	266–274
Neurotoxicity	5-HT <sub>4</sub> receptor, 319–320	agonist binding, 268–269
glutamate receptors, 363	5-HT <sub>5</sub> receptor, 320–321	agonist densitization, 269, 270f
dietary neurotoxin activation and cell	5-HT <sub>6</sub> receptor, 320	biochemical characterization, 266–267, 267f
death, 363	5-HT <sub>7</sub> receptor, 320	brain function modulation, neuronal
polyglutamine protein misfolding, 845–846	mental illness and 5-HT <sub>1A</sub> , 316	receptor, 271
Neurotoxin labeling, sodium ion channel,	subtype definition, 313–314	cys-loop ligand-gated ion channel family,
69–71, 70f	subtype research, 314	268f, 269
Neurotransmission	serotonin transporter, acute and chronic	disease and, 272–273
exocytosis, synaptic vesicle trafficking,	regulation, 309–310	ion channel communication, 269
139–142	synapse termination, 308–309, 310f	neuronal receptor family, 269–270, 270f
neuropeptide receptors, 401–402	synthesis conditions, 306	non-neuronal distribution, 272
Neurotransmitter receptors	vesicle storage and exocytotic release,	pentameric ligand-gated ion channels,
aminoacidurias and deficits in, 742	306–308, 307f, 308f	267–268, 268f
G protein ion channel coupling, 412–414	volume and paracrine neurotransmission, 311	subunit permutations and diversity, 270f, 271
myelin composition, 197	911	2/1

phosphorylation, catalytic domains, 494-498

Nicotinic acetylcholine receptors (nAChRs), Nonreceptor protein tyrosine phosphatases G-protein-coupled signaling cascade, (Continued) 913-914 (NRPTPs), schematic structure, therapeutic targeting, 273-274 ion channel interaction, salts and acids, 914 transgenic research, physiology and clinical Noradrenergic neurons, dopaminereceptor cells, 912 implications, 271-272 norepinephrine conversion, 286 vomeronasal organ Niemann-Pick diseases Noradrenergic system semiochemical detection, 910 type C, 760 anxiety disorders, 1030-1031 sensory transduction, 911, 911f types A and B, 760 mood disorders, 1023 Olfactory bulb, olfactory sensory neuron convergence, 907 Nissl substance, 6-7 Norepinephrine Nitric oxide cell-surface receptor binding, 293-295, 294f, Olfactory sensory neurons (OSNs) molecular signaling mechanisms, cell 294t action potentials, 907-908 surface receptors, intercellular dopamine conversion, adrenergic/ convergence, olfactory bulb, 907 signaling, 249-256 noradrenergic neurons, 286 subpopulations, 909-910 soluble guanylyl cyclase regulation, 433 epinephrine metabolism, neurons and Oligodendrocytes adrenal medulla, 288 integrin myelin regulation and, 173-175 Nitric oxide synthase, ischemia-reperfusion injury, 631 metabolism, 292 myelin production, central nervous system, Nitrogen shuttles, brain energy metabolism, sleep regulation and wakefulness, 986 13, 13f, 570-574, 573f Norepinephrine transporters (NET) transcriptional and epigenetic regulators, N-methyl-D-aspartate (NMDA) receptors catecholamine termination, 289 572-574 Oligomeric structures, polyglutamine protein aminoacidurias and deficits in, 742 psychomotor stimulant addiction, 1043-1044 glycine activation, 250-251 Notch signaling, neurogenic development, misfolding, 846 GTPase activation, 361 Oligosaccharide formtion, biosynthetic identification, 347-356 NRG1/ErbB receptor signaling, myelination secretory pathway, Golgi ischemic injury regulation, 574, 575f complex sorting and brain function and cell death, 628-629, 629f Nuclear DNA (nDNA) glycosylation, 129 downstream death signals, 629 defects of, 774-775 O-linked glycosylation, biosynthetic secretory learning and memory research, NR2B mitochondrial DNA communication pathway, membrane and secretory targeting, 972-973 defects, 775 proteins, 130 Opiate peptides, identification, 391-392, long-term potentiation induction, 966-967, Nuclear envelope, 7f Nucleosome, histone modification, multiple regulatory sites, 350-354, 352f neurodegenerative disease Opiates phospholipid esterification, 645-646, 646f epigenetics, 731-733 addiction to, 1041-1043 schizophrenia and hypofunction of, Nutrient exchange. See also Diet and nutrition cannabinoid similarities, 1048 1005-1007 blood-brain barrier, 18-19 tolerance, adenylyl cyclase regulation, tyrosine phosphorylation, 510-511 endocytic pathway, 135-137 328-329 Nociceptive pain, 928–929 Opiate withdrawal syndrome, 1043 O dorsal horn, 930 Opioid analgesia pain management, 933 genetic factors, 939 Obesity sleep disruption, 993-994 Nociceptors neuropeptides, 405 pain management, 929-930 peripheral neuropathies and, 687 Opioid receptors, addiction and, 1041 receptor profiles, 929-930 Odorant receptors, smell Optic atrophy 1 (OPA1), dynamin proteins gene encoding, 905-906, 906f Nodal proteins, myelin sheath, 195 and, 124 odor discrimination, 906 Optic nerve, ganglion cell axons, 890–891 Nodes of Ranvier, 14, 15f zonal expression, 907 myelin ultrastructure, 182-183, 184f, 186f OPTN gene mutation, amyotrophic lateral sclerosis, 805-806 sodium channel concentration, 67 Odor discrimination, odorant receptors, 906 Nogo-A protein Olfaction Orexins, sleep regulation, 989-990 axonal regeneration adenylyl cyclase targeting, 430 Organ dysfunction, peroxisomal diseases, antibodies and peptides, 588 epithelium, 905, 905f 760-761 neurite growth inhibition, 586, 586f, 587f guanylyl cyclase receptors, 432 Organelle traffic neuronal expression, neurite growth biosynthetic secretory pathway, Golgi mammalian processes, 904 regulation, 589 negative feedback, olfactory transduction, apparatus polarization, 129 compensatory plasticity, adult brain injury, 908-909 calcium pools and, 458-461 591-592, 591f odorant receptors intracellular membrane trafficking, dynamin gene encoding, 905-906, 906f spinal cord injury, fiber growth and protein targeting, 123-124 regeneration, 592 odor discrimination, 906 lysosomal storage diseases, 755-756 Nogo gene, axonal regeneration, 587-588 zonal expression, 907 microtubule tracking, 102-106, 103f, 104f, knockout mouse studies, 588 olfactory sensory neurons 105t, 107f Non-declarative memory, 965 action potentials, 907-908 peroxisomal diseases, 760-761 Nonketotic hyperglycinemia, 744-745, 745f convergence, olfactory bulb, 907 Organic acids, aminoaciduria disorders, 738, Non-neuronal nicotinic acetylcholine subpopulations, 909-910 Ornithine transcarbamylase deficiency, 750 receptors, 272 second-messenger cascade, odorant Non-rapid eye movement (NREM) sleep, recognition, 907-908, 908f Orphan receptors neurochemical substrates, 983 social communication and, 909-910 neuropeptide identification, 392 Nonreceptor protein tyrosine kinases (NRPTKs) taste, 911-914, 912f serotonin receptor subtypes as, 320-321 cranial nerves, 912 Outside-in signaling, integrins, cell adhesion

G-protein-coupled receptors, 912-913

molecules, 172-173, 175f

etiology, 861-862 Charcot-Marie-Tooth and hereditary Oxidation-phosphorylation coupling defects, familial PD, SNCA gene mutations, 831, 831f motor and sensory neuropathies, genetics, 722t, 723-725, 723t, 724t 680-684 Oxidative deamination, serotonin catabolic autosomal dominant, 723 infection-related disorders, 687 pathway, 310-311 autosomal recessive, 723-724 molecular motors and peripheral Oxidative phosphorylation, mitochondrial candidate-gene studies and genome-wide neurpathies, 688 heterogeneity, 219-220 screening, 724–725 muscarinic cholinergic receptor mediation, Oxidative stress mutations, 832-833 apoptosis activation, 668 host-to-graft Lewy body spreading, 832f myelin lipid peroxidation, 657 neuroprotective treatment, 864-865 in cell membrane, 183, 187f 5-Oxoprolinase deficiency, 752, 753f central nervous system myelin nicotinic acetylcholine receptor targeting, 5-Oxoprolinuria, glutathione synthetase 273 comparisons, 187-188 deficiency, 752 pathology, 861 deficiencies of, 701 Oxygen peroxide metabolism, peroxisomal pathophysiology, 862-863 perpheral neuropathies and loss of, 578 diseases, 760-761 purinergic  $A_{2A}$  receptors, 387–388 proteins in, 192-193 Oxytocin, identification, 391-392, 391f sleep regulation and, 989 regeneration and remyelination, 579-580 neural crest stem cells, 560-561 stem cell repair, 563-564 surgical therapy, 864 neuroanatomy, 680  $P_0$  glycoprotein, peripheral nervous system symptomatic drug treatment, 863-864 pain management, 934 myelin, 192 Pathogen-associated molecular patterns Schwann cell myelin production, 13-15, P<sub>2</sub> protein, peripheral nervous system 570, 571f, 572f (PAMPS) myelin, 180 APC function and T-cell differentiation, 602 Periventricular leukomalacia (PVL), neuroimmunology, 597 p38 MAPKs, phosphorylation, 477 myelination and, 579 p75 neurotrophin receptor, 552–553, 553f neuroinflammation, 616-617 Permeation pathways, ionotropic glutamate Pain management Pattern recognition receptors (PRRs), receptors, 356 adenylyl cyclase cAMP targeting, 430 neuroinflammation, 616-617 Peroxisomal diseases brainstem, thalamus and cortex, 931-933, Pelizaeus-Merzbacher disease, myelination biogenesis defects, 761 and, 578 classification, 761-762 cannabinoids, 933-934 Penfield studies, learning and memory, 964 epidemiology and pathology, 760-761 cGMP signaling, guanylyl cyclase Pentameric ligand-gated ion channels single enzyme defects, 761-762, 762t receptors, 434 GABA<sub>A</sub> receptors, 370-372, 372t therapy, 762 clinical challenges in, 938-939 nicotinic acetylcholine receptors, 267-268, Perpheral neuropathies, myelin loss and, 578 dorsal horn signal transmission, 930, 931f Phagocytosis genetic factors, 939 Pentose phosphate shunt (PPS), brain energy endocytic pathway, macromolecular histamine and, 337 metabolism, 210 degradation and nutrient uptake, inflammatory pain, 934-936, 935f Peptides. See also Neuropeptides neuropathic pain, 936–939 disease mechanisms, 404-406 microglia activation, 612 nicotinic acetylcholine receptor targeting, 273 enzyme-based biogenesis, 394-399, 394t, microglia and, 15f, 15-16 nociceptive vs. clinical pain, 928-929, 929f Pharmacological agents 396f, 398f nociceptor function, 929-930 as first messengers, 392 ion channel function, 68-69 opioid analgesia, 933 identification techniques, 392 phosphodiesterase targeting, 438 purinergic receptors, 387 neurotransmitter release, eukaryotic cells, Phencyclidine addiction, 1050 sleep disorders and 237-238 Phenylalanine hydroxylase, phenylketonuria acetylcholine, depression, and REM sleep, propeptide families, 399-400, 401f and deficiency in, 743-744 Phenylalanine metabolism, phenylketonuria receptor-mediated transcytosis, 22 glutamate modulation, 992-993 structure and function, 391-392, 391f and, 743-744 opioid-induced sleep disruption, adenosine toxins, muscle excitation alteration, Phenylethanolamine-N-methyltransferase and, 993-994 796-798 (PNMT), norepinephrine spinal cord transmission, 930-931 Pericytes, blood-brain barrier, 19 metabolism to epinephrine, 288 voltage-gated sodium channels, 930 Perikaryon, 4-6, 5f Phenylketonuria, 743-744, 743f Paired helical filaments (PHF) structural morphology, 6-7 phenylalanine hydroxylase deficiency, 743-744 neurofibrillary tangles, Alzheimer's Peripheral anionic site (PAS), Phosducin, G protein subunit regulation, 416 disease, 818-819 acetylcholinesterase, 265, 265f Phosphatases tau protein, 835 Peripheral myelin protein-22 phosphoinositide dephosphorylation, Paracrine neurotransmission genetic peripheral neuropathies, 682 445-446 neuropeptide receptors, 402 peripheral nervous system myelin, 192-193 protein Ser/Thr phosphatases, serotonin, 311 Peripheral nervous system phosphorylation, 479-482, 479t Paramyotonia, congenital, 790-791 autoimmune neuropathies, 684-687, 686f, dual-specificity phosphatases, 481 Paranodal proteins, myelin sheath, 195 protein phosphatase-1, 479-480 Paraproteinemic polyneuropathy, 698 axon degeneration and protection, 687-688 protein phosphatase-2A, 480 Parenchyma, leukocyte migration, CNS protein phosphatase-2B, 480-481 demyelinating neuropathies, 697-699 immune activity, 604-605 development and target interactions, protein phosphatase-2C, 481 Parkinson's disease 541-542 protein tyrosine phosphatases, 501-505, 504f animal models 863f, 862 diabetic neuropathy, 684, 685f cysteine residue, 503-504 basal ganglia involvement, 861-865 genetically determined neuropathies, dual-specificity phosphatases, 505, 506f connectivity losses in, 869-870 680-684, 681-682t RPTPs 505, 504f

Phosphatidylinositol 3-kinase, ischemia-reperfusion signaling, 654, 655f protein Ser/Thr phosphatases, 479-482, phosphoinositide synthesis, 444 secretory properties, 647 Phosphatidyl serine, protein-lipid binding, Phospholipids dual-specificity phosphatases, 481 29, 31f amphipathic molecules, 27-28, 28f protein phosphatase-1, 479-480 Phosphocreatine, brain energy metabolism, basic properties, 26-28 protein phosphatase-2A, 480 ATP levels, 218 biological membranes, 29-36 protein phosphatase-2B, 480-481 Phosphodiesterases (PDEs) lipid mediator pathways, 644-647 protein phosphatase-2C, 481 cGMP signaling, guanylyl cyclase cyclooxygenases, 652-653 tyrosine, 493, 494f receptors, 433 diacylglycerol kinases, 654 acetylcholine receptors, 510, 510f drug targeting, 438 docosahexaenoic acid, 656-657 GABA receptors, 511 families, 434, 435t, 436f docosanoids, 657 neuromuscular synapse, 509 calcium/calmodulin-stimulated PDEs, eicosanoids, 648-649, 648f, 649f, 650f neuronal development, 505-508, 508f 434-435 lipid peroxidation and oxidative stress, 657 NMDA receptors, 510-511 cGMP-regulated PDEs, 435-436 lipoxygenases, 653-654 protein tyrosine kinases, 494-501, 495f G protein-activated PDEs, retinal messenger function, 645 enzyme domains, 494-498, 496f, 498f, phototransduction, 436-437 neuroinflammation, 654-656, 655f 499f, 497t PDEs 7, 8, and 9, 438 neurolipidomic signaling, 657-660 pleiotropic receptor mutations, 507 phosphorylation regulation, 437 neuroprotectin D1, 657, 658f receptor domains, 498-501, 500f transducin activation, 896f phospholipase cleavage, 645 RPTK activation, 500, 500f phospholipases A<sub>2</sub>, 647–648 Phosphoenolpyruvate carboxykinase RPTK inactivation, 500-501, 501f (PEPCK) deficiency, 771 platelet-activating factor, 649-652, 651f RPTK phosphorylation, 501, 502-503f Phosphofructokinase, brain glycolysis polyunsaturated fatty acyl chains, 645-646, protein tyrosine phosphatases, 501-505, regulation, 208 504f Phosphofructokinase (PFK), glycolytic synaptic membrane targets, 645 cysteine residue, 503-504 defects, 764-766 translational neurosciences, 659 dual-specificity phosphatases, 505, 506f Phosphoglycerate kinase (PGK), 771 transmembrane ion gradients, 644 RPTPs 505, 504f membrane protein interactions, 29-31 glycolytic defects, 764-766 synapse formation, 509-511 Phosphoglycerate mutase (PGAM), glycolytic protein arrays, 26-27 voltage-gated ion channels, 511 Phosphotyrosine binding (PTB) domaindefects, 764-766 protein-lipid binding, 29, 30f Phosphoinositides transmembrane domains, 28-29, 29f containing signaling proteins, 498f cell growth and survival, 452 Phosphoprotein, tau protein as, 835 Photoreceptors cell regulation, 451-453 Phosphorylase b kinase (PHK), genetic downstream signaling, 897-898 diacylglycerol, 449-451 defects, 763 organization, 892, 892f, 893f protein kinase C as second messenger, Phosphorylase deficiency, 763 retinal neurodegeneration, 899 449-451, 450f Phosphorylation rhodopsin and docosahexaenoic acid inositol lipids, 443-448, 444f cell regulation, 467-470, 468f (DHA) phospholipids, 656-657 cell regulation, 451-453, 451f G protein function and, 418 rhodopsin regeneration, 898-899 Charcot-Marie-Tooth disease, 445 human kinome, 471f Phototransduction cone phototransduction, 895-897 myo-inositol in cells, 449 D-myo-inositol 1,4,5-trisphosphate, calcium liberation, 448-449, 448f neuronal phosphoproteins, 482-484, 483f G protein-activated phosphodiesterase, ligand-activated hydrolysis, neural tissue, oxidation-phosphorylation coupling 436-437 guanylyl cyclase receptors, 432 defects, 776 phosphatase dephosphorylation, 445-446 phosphodiesterase regulation, 437 molecular recycling, 898-899 phosphatidylinositol 3-kinase synthesis, polyglutamine repeat diseases, 849-850 organization, 892-894 3'-phosphoinositides, 444 protein kinases/phosphatases Pick's disease, 836 phospholipase C isozyme cleavage, antagonistic actions, 468-470, 471f Pilocarpin model, epilepsy, dentate 446-448, 446f, 447f cognitive enhancement, 486-487 granule cells, synaptic input structure and metabolic function, 443-444, CREB transcription factor, 488f, 489 abnormalities, 709 Pinocytosis, endocytic pathway, 443f extrasynaptic mechanisms, 489 macromolecular degradation and inositol phosphates, 448-449 hereditary neuronal disorders, 474t, metabolism and free inositol regeneration, 489-491 nutrient uptake, 135-137 449, 449f neuronal functions, 481-482 Plasmalemma postsynaptic mechanism regulation, myo-inositol cell presence, 449 axonal regeneration, 585 membrane trafficking, 451-452 487-489 primary plasma membrane calcium Phospholipase C (PLC) isozymes, presynaptic mechanism regulation, 485transporter, 48 phosphoinositide cleavage, 487, 485f sodium-potassiumadenosinetriphosphatase 446-448, 446f, 446t, 447f synaptic plasticity and memory functions, Phospholipases 484–489, 484t regulation, 45, 46f protein Ser/Thr kinases, 470-479 lipid messengers, cleavage from Plasma membrane phospholipids, 645 distribution, substrate specificity and biosynthetic secretory pathway, transphospholipases A, 2 regulation, 470-473, 472f Golgi network sorting, plasma MAPK cascade, 476-478, 476f cytosolic lipid formation, 647 membrane proteins, 131-132 fatty acyl chain cleavage, phospholipids, 647 second messenger-dependent proteins, calcium homeostasis, 457-458 473–476, 474t high-affinity receptors, 647-648 efflux pathways, pumps and transporters, ischemia and seizures, arachidonic/ second messenger-independent proteins, 458 476, 478-479 docosahexaenoic acid release, 647 influx pathways, 458

cAMP-dependent phosphorylation, 473

cholesterol and phospholipid translocation, Postsynaptic mechanisms future research issues, 883 glycinergic neurotransmission, 250-251 ABCA1, 51-52 genetics, 730-731 lipid composition, 31 accessory protein mutations, receptor host encoding, 873 structure, 27f localization, 253-254 human diseases, 874-876, 874f Plasma membrane calcium transporter GlyRα1 mutations, 253 metabolic dysfunction, 873 (PMCA), basic properties, 48 protein phosphorylation, 487-489 pathology and pathogenesis, 876-877, 876f Plasma membrane integral proteins (PMIPs), Post-translational modification peripheral pathogenesis, lymphoreticular cholesterol synthesis and, 32-33 peptide diversity, 399-400 system, 876 Platelet-activating factor (PAF) polyglutamine repeat diseases, 849 prion strain diversity, 880-882, 881f cyclooxygenase-2 transcriptional activator, Potassium protein identification, 873 protein-only propagation hypothesis, 877, membrane potential, 64-65, 64f hippocampal kainic-acid-induced neuronal extracellular clearance, 58 cyclooxygenase-2 expression, 654 Potassium ion channels PrPc Andersen syndrome, 791 lipid mediator pathways, 649-652, 651f alpha-helical conformation, 877-878, 878f Platelet hyperserotonemia, autism spectrum genetic identification, 71 knockout mice studies, 878-879 G protein inward-rectifying potassium disorders, 1015-1016 reverse genetics, 878 Pleckstrin-homology (PH) domain, proteinchannel (GIRK), neurotransmitter unknown function, 878 PrPSC characterization, 879-880, 879f lipid binding, 29, 30f receptor coupling, 412-414 Pleiotropic mutations inwardly rectifying channels, 71 alternative conformation and infectivity, lysosomal storage diseases, 757-760 Isaac syndrome and neuromyotonia, 794-795 protein tyrosine kinase phosphorylation, beta-sheet conformation, 879 multiple gene families, 76 tau, amyloid-beta and synuclein Plurichemical coding, peptide-based Prefrontal cortex aggregates, 883-884 neuronal signals, 403 pain management, 931–933 transmission barriers, 882-883 Pluripotent stem cells, reprogramming and stress and, 949-951 Prion protein beta-sheet conformation, 879-880, 879f directed differentiation, 562-563 Premitochondrial events, apoptosis Polar water molecules, hydrophobic lipid activation, 669-670 gene mutations, 874-875, 874f bilayers, 56-57 Presenilin 1 and 2 genes, familial Alzheimer's isoform conversions, 877 Polygenetics, autism spectrum disorders, alpha-helical conformation, 877-878, 878f disease, 817 Prestin, electromotility, 925f polymorphism, 875 Polyglutamine disease protein, 845, 847f strain diversity, 880-882, 881f Presynaptic events acetylation, 850 botulinium toxin alteration, 795-796 transmission barriers, 882 ataxin-1 complex, 849 metabotropic glutamate receptor in vitro generation and infectivity, 880 ataxin-7 disruption, 849 modulation, 359 PRNP mutations, prion disease genetics, 730 autophagy pathway, 848f protein phosphorylation, 485-487 Procedural memory, 965 gene silencing therapy, 850-853, 851f synaptic transmission, 241-245 Programmed cell death, cell morphology and misfolding and toxicity, 845-846 Presynaptic terminal biochemistry, 672 phosphorylation, 849-850 cell adhesion molecules, synapse Progressive motor neuropathy (PMN), post-translational modification, 849 regulation, 176-177 tubulin-specific chaperone RNA toxicity, 850 synaptic vesicle trafficking, 139 mutations, 808 transglutaminase inhibition therapy, Presynaptic vesicles Progressive multifocal leukoencephalopathy, 852-853 glycinergic neurotransmission, glycine turnover pathways and pathogenesis, transporter 2 mutations, 254 Progressive supranuclear palsy, 836 846-849 neurotransmitter packaging, proton-Progressive weakness, glucose and fatty acid coupled antiporters, 54 metabolic disorders, 766 PolyQ-htt enzymatic aberration. See also Polyglutamine disease protein neurotransmitter uptake and storage Proneurotrophins, 551, 551f Huntington disease epigenetics, 731-733 physiology, 55 Pro-opiomelanocortin (POMC) precursor Polyunsaturated fatty acids Primary active transport (P-type) pumps bioactive peptide production, 394, 395f, ischemia-reperfusion injury, 631 ATP-binding cassettes, 50–52 398f basic properties, 41-42, 41f neuropeptide derivation, 392-393, 392f phospholipid esterification, 645-646 Pontine cholinergic neurotransmission, REM calcium adenosinetriphosphatases, 48 Propeptide families, peptide diversity, sleep and, 988 plasma membrane calcium transporter, 48 399-400 Pontine reticular formation, GABAergic P-type copper transporters, 50 Prostaglandin pathways neurotransmission, sleep and smooth endoplasmic reticulum calcium cyclooxygenase arachidonic acid wakefulness, 991 conversion, prostaglandin H<sub>2</sub>, pumps, 48-50 Positron emission tomography (PET), brain sodium-calcium antiporters, 48 sodium-potassiumenergy metabolism, 223 neuroinflammation, 614-615 Postmitochondrial events, apoptosis adenosinetriphosphatase, 42-48, neuron and glial cell release, 648-649, 650f activation, 670 Protectins Postmortem brain studies, autism spectrum  $V_0V_1$  proton pumps, 50 docosanoids, 657 disorders, 1014 Prion diseases lipoxygenases and, 653 Postsynaptic density (PSD), glutamate animal diseases, 873-874 Protein, aggregation, neuroinflammation and, ionotropic/metabotropic scrapie and BSE, 873-874 613-614 receptors, 347, 349f central nervous system pathology, 876 Protein kinase A (PKA) distribution, 359-360 clinical heterogeneity, 875-876 adenylyl cylcase molecular targeting, 329

epidemiology, 873

protein activity, 360-361

Protein kinase C (PKC) proteolipid protein, 188-189 P-type copper transporters, neural function diacylglycerol activation, 449-451, 450f sorting and transport, 575-576 and, 50 mood disorders and, 1027 myelin sheath, 194-197 Purinergic receptors, 382-384, 382f phosphorylation, 473-475 enzymes, 195-197 adenosine subtypes, 382, 382t Protein kinase G (PKG) miscellaneous proteins, 197 A<sub>1</sub> receptors, 383, 383f cGMP signaling, guanylyl cyclase neurotransmitter receptors, 197 A<sub>2A</sub> receptors, 383, 383f receptors, 433 nodal, paranodal, and juxtaparanodal Parkinson's diesase and antagonists of, 387-388 phosphorylation, 473 proteins, 195 A<sub>2B</sub> receptors, 384 Protein kinases, phosphorylation tetraspan proteins, 194-195 antagonistic actions, 468-470, 471f neuronal structure and function, A<sub>3</sub> receptors, 384 calcium/calmodulin-dependent kinases, schizophrenia, 1008 P<sub>2</sub> receptors, 384 475-476 neurotransmitter release, eukaryotic cells, ionotropic receptors, 384 casein kinase, 1, 478-479 237-238 nervous system disorders, 387-388 c-jun NH2-terminal kinases, 477-478 phosphorylation. See Phosphorylation pain management, 387 protein-lipid binding, 29 CREB transcription factor, 488, 489f Purines cyclin-dependent kinases, 5, 478 synaptic vesicle trafficking, 140-141t alcohol effects, 387 astrocyte-mediated, adenosine-dependent extracellular signaling-regulated protein Protein Ser/Thr kinases, phosphorylation, kinases, 477 470-479 heterosynaptic depression, 385 extrasynaptic mechanisms, 489 distribution, substrate specificity and ATP-adenosine, 384-385 genetic neuronal disorders, 489-490 regulation, 470-473, 472f glial-derived ATP and adenosine, MAPK cascade, 476-478, 476f glycogen-synthase kinase-3, 478 respiration and sleep, 385-386 hereditary neuronal disorders, 474t, 489-491 second messenger-dependent proteins, microglial injury response, 386, 386f myelination and axonal ATP release, 385 neuronal functions, 481-482 473-476, 474t p38 MAPKs, 477 second messenger-independent proteins, nervous system effects, 384-387 postsynaptic mechanism regulation, 487-489 476, 478-479 neurological disease and, 387 presynaptic mechanism regulation, Protein Ser/Thr phosphatases, nomenclature, 377, 378f 485-487, 485f phosphorylation, 479-482, 479t pain management, 387 synaptic plasticity and memory functions, dual-specificity phosphatases, 481 pH-dependent astrocyte release, breathing 484-489, 484t protein phosphatase-1, 479-480 control, 386 Protein-only hypothesis, prion propagation, protein phosphatase-2A, 480 release, 377-382 877, 877f protein phosphatase-2B, 480-481 release and metabolism, 378f Protein phosphatases, phosphorylation, protein phosphatase-2C, 481 extracellular adenosine sources, 379-380, genetic neuronal disorders, 489-490 Protein tyrosine kinases, phosphorylation, Protein-protein interactions, 494-501, 495f extracellular nucleotide regulation, 379 acetylcholinesterase, 266 enzyme domains, 494-498, 496f, 497t, 498f, inherited diseases, 381 Proteins. See also Membrane proteins; Pyridoxine Secretory proteins. specific nonreceptor protein tyrosine kinases, 494-498 dependency disorder, 753 sulfur amino acid metabolism disorders, proteins pleiotropic receptor mutations, 507 receptor domains, 498-501, 500f biosynthetic secretory pathway 747 Golgi cisternae transport, 130-131, 131f RPTK activation, 500, 500f Pyrimidines, nomenclature, 377, 378f lysosomal proteins, trans-Golgi network RPTK inactivation, 500-501, 501f Pyruvate, brain energy metabolism sorting, 132 RPTK phosphorylation, 501, 502-503f astrocytic carboxylation, 218 plasma membrane proteins, trans-Golgi Protein tyrosine phosphatases, glucose conversion to (glycolysis), 207-209 phosphorylation, 501-505, 504f glycolysis production, 208-209 network sorting, 131–132 cytoskeleton expression cysteine residue, 503-504 lactate-pyruvate interconversion, 211 injury and regeneration, 114 dual-specificity phosphatases, 505, 506f pyruvate-lactate compartmentation, 214 phosphorylation, in neuropathology, 116 RPTPs, 504f, 505 Pyruvate carboxylase deficiency, 771–772 fast axonal transport, molecular sorting, Proteolipid protein (PLP), central nervous Pyruvate dehydrogenase complex, 154-155 system myelin, 188–189 tricarboxylic acid cycle, 217 glutamate receptor activation, 360-361 Proteolytic processing, peptide diversity, heterotrimeric G protein modulation, 416-418 399-400 immunoglobulin-like domain, cell Protofibrils, polyglutamine protein Q/R site, glutamate receptors, 354-356, 356f adhesion molecules, 166, 167f misfolding, 846 Quantal analysis, synaptic transmission ion channel conformation, voltage-Proton-coupled antiporters, presynaptic exocytosis, 239, 242f dependent gating mechanisms, vesicles, neurotransmitter Quinoxalinediones, AMPA/kainate receptor 68, 69f blockage, 350 packaging, 54 lipid bilayers, 26-27 Proto-oncogenes, G proteins and, 420 myelin composition PSD95 scaffolding protein, glutamate R myelin-associated glycoprotein, 191-194 ionotropic/metabotropic Rab proteins myelin basic proteins, 189-190, 190f, 193 receptors, postsynaptic density, hereditary sensory-motor neuropathy and, 360-361 P<sub>0</sub> glycprotein, 192 421 P<sub>2</sub> protein, 193 Psychomotor stimulants, addiction, intracellular membrane trafficking, target peripheral and central nervous system 1043-1045, 1044f, 1046f membrane recognition, 125 myelin, 187-188 Psychosine, 778-779 membrane vesicle trafficking, 419, 419f peripheral myelin protein-22, 192-193 Psychostimulant, sleep regulation, Radial glia stem cells, 560, 560f peripheral nervous system proteins, 192-193 norepinephrine, 986 Rapid eye movement (REM) sleep

acetylcholine and, 987-988 multiple sclerosis, 702 phototransduction, 898-899 depression, and pain and, 988 therapeutic targeting of, 703 Ribonuclear inclusions, myotonic dystrophy, cholinergic neurotransmission, 988 Reperfusion damage 791-792 dopamine and, 988-989 free radicals, ischemia-reperfusion injury, RNA editing, glutamate receptor neurochemical substrates, 983 629-631 heterogeneity, 354-356 Rapsyn deficiency, 790 reactive oxygen species, 629 RNA interference (RNAi), polyglutamine Ras protein family, small G protein ischemia, phospholipase A2 signaling, 654, repeat diseases, 850-851 characterization, 418-419 RNA metabolism, amyotrophic lateral Reactive oxygen species (ROS), ischemianeuroinflammation, ischemia and, 616 sclerosis, 804-805 reperfusion injury, 629 neuroprotectin D1 inhibition, 657 RNA polymerase II, transcription and, 516 excitotoxic and apoptotic consequences, 631 Resolvin pathway RNA toxicity, polyglutamine repeat diseases, docosanoids, 657 sources of, 631 Readily releasable pool (RRP), synaptic lipoxygenases, 653 Rodent mutant studies, myelination and transmission, presynaptic events, neuroinflammation, 616 genetic disease, 576-577, 577t Respiration Rostrocaudal axis, central nervous system Real-time memory visualization, 974, 976f ATP-adenosine signaling, glial cells, 385–386 development, 535-538 Receptor-mediated endocytosis (RME), pH-dependent purine release, astrocyte Rough endoplasmic reticulum (RER), endocytic pathway, clathrin-coatcontrol, 386 biosynthetic secretory pathway, dependent process, 137-139, 138f Respiratory chain abnormalities, 776 membrane-associated polysomes, Receptor-mediated signaling, cell signaling coenzyme Q10 deficiency, 777 126-127 complex I, 776-777 mechanisms, 246 Ryanodine receptor, calcium release channels, Receptor-mediated transcytosis (RMT), complex II, 777 malignant hyperthermia, 792–793 peptide and signaling molecule complex III, 777 transport, 22 complex IV, 777-778 Receptor protein tyrosine kinase (RPTK) complex V, 778 S-adenosylmethionine (SAM), methyl group activation, 500, 500f Restless legs syndrome, 989 transer, neurodegenerative ErbB family, neuromuscular synapse, 509 Reticulon superfamily, axonal regeneration, disease epigenetics, 731-733 extracellular, single transmission and nogo gene, 587-588 Saltatory conduction, myelin facilitation, cytoplasmic domains, 498-501 Retina 180-181, 181f GFL receptors, 554-555 anatomy, 890f Sandhoff disease, 759-760 neurodegeneration, 899-900 Sarcoplasmic reticulum, smooth endoplasmic inactivation, 500-501 molecule-directed therapies, 900 reticulum calcium pump, 48 pleiotropic mutations, 507 neuronal sublayers, 890, 891f structure, 495f Sarcoplasmic reticulum calcium ATPase, Trk receptors, 552 Retinal phototransduction, G protein-Brody disease and, 793 tyrosine phosphorylation, 501, 501f, activated phosphodiesterase, SCC8 gene family, anion antiporters, 56 502-503f Schizophrenia Retinal pigmented epithelium (RPE), rhodopsin Receptor protein tyrosine phosphatases atypical antipsychotic drugs, 1001-1002 (RPTPs), structure, 504f regeneration, 898-899, 898f brain imaging, 1003-1004 cellular and molecular studies, 1004-1009, Receptor tyrosine kinases (RTKs), molecular Retinal tissue, docosahexaenoic acid (DHA) signaling mechanisms, cell surface pathways, 656 1006f receptors, 248 Retinoid recycling, rhodopsin regeneration, cholinergic agonists and antagonists, 1008 Redox signaling, superoxide dismutase type 898-899, 898f clinical aspects, 1000–1003 Ret receptor tyrosine kinase, GFL receptors, corticolimbic abnormalities, 1003-1004 1 mutations, 810 Reelin signaling, neurogenic development, 539 554-555 dopamine hypothesis, 1004-1005 GABAergic neurons and, 1007–1008 Refractory status epilepticus, GABA receptor Retrograde amnesia, memory consolidation endocytosis, 373 and, 971 genetics, 1001, 1009-1010 Retrograde axonal transport, fast transport, gial cells, 1008-1009 Regeneration axonal growth and, 582-583, 583f trophic factors, exogenous intracellular signaling, 1008 central nervous system, 451f, 585-590 NMDA receptor hypofunction, 1005-1007 material and membrane axon growth, glial scar inhibition, 589-590 symptom clusters, 1001 constituents, 153-154 knockout studies, nogo gene development, Reverse genetics, prion protein analysis, 878 Schmidt-Lanterman clefts, myelin Reward circuitry, opioid system, 1043 ultrastructure, 183, 184f RGD amino acid sequence, integrin receptors, myelin components, 588-589 Schwann cell neurite growth inhibition, 589 cell adhesion, extracellular matrix axonal regeneration, 584 neurotrophic factors, 590 proteins, 170-172 myelination and development of, 570, 571f Nogo-A inhibitor, 586, 587f, 588, 589 RGS protein myelin production, peripheral nervous reticulon superfamily, 587-588 cognitive dysfunction and, 420 system, 13-15, 14f spinal cord injury, fiber growth and heterotrimeric G protein modulation, SCN1A gene mutations, epilepsy genetics, regeneration, 592 416-417, 417f cytoskeletal protein expression, 114 Rhabdomyolysis, phosphorylase deficiency, 763 Scrapie, prion protein dysfunction, 873-874 peripheral nervous system, 583-585 Rheb protein, tuberous sclerosis and, 421 Secondary active transport, 52-55 Regulated secretory pathway Rhodopsin carboxylic-acid transporters, 53 neuronal secretory cells, 133f, 134 calcium ion channel mediation, 894-895 choline transporter, 54 synaptic transmission, neuroendocrine conformational activation, 894f glutamate symporters, SLC1 proteins, 53 definition, 245 docosahexaenoic acid (DHA) pathways neurotransmitter sodium symporters, 52, Remyelination, 579-580 and phospholipids, 656-657

Secondary active transport (Continued)	synaptic plasticity and memory	Serotonin transporter (SERT)
proton-couple antiporters, 54	functions, 484-489, 484t	acute and chronic regulation, 309-310
SLC6 symporter subfamily, 52–53	protein Ser/Thr kinases, 470–479	drug inhibition, 307, 308f
sodium-dependent D-glucose symporter,	distribution, substrate specificity and	psychomotor stimulant addiction,
brain capillary endothelial cell and neuron expression, 52	regulation, 470–473, 472f MAPK cascade, 476–478, 476f	1043–1044 synapse termination, 308–309
Second messenger system	second messenger-dependent proteins,	17kDA tetraspan protein, myelin sheath, 194
addiction, cyclic AMP upregulation and,	473–476, 474t	Short-term memory, 965
1042–1043	second messenger-independent proteins,	Signaling mechanisms
diacylglycerol, 449–451	476, 478–479	energy requirements, 201–202
G protein regulation, intracellular	protein Ser/Thr phosphatases, 479–482,	histamine receptors, 334f
signaling, 414–415	479t	neuropeptides, 403
inositol lipids, cell regulation, 451–453	dual-specificity phosphatases, 481	psychomotor stimulant addiction,
inositol phosphates, 448–449	protein phosphatase-1, 479–480	dopamine receptors, 1045
mechanisms, 423, 424f	protein phosphatase-2A, 480	tau protein scaffolds, 840
odorant recognition, 907–908, 908f protein Ser/Thr kinases, 472f, 473–476, 474t	protein phosphatase-2B, 480–481 protein phosphatase-2C, 481	Signaling microdomains, sodium-potassium- adenosinetriphosphatase
Secretory proteins	Serotonergic system	scaffolds, 48
axonal transport, fast transport 151-152,	anxiety disorders, 1031	Signaling molecules
150f, 151f, 152f	mood disorders, 1022–1023	pain management, 934
Golgi complex sorting and glycosylation,	Serotonin	receptor-mediated transcytosis, 22
biosynthetic secretory pathway,	amino acid L-tryptophan precursor, 304-	Signal recognition particle (SRP), biosynthetic
129–130	306, 305f	secretory pathway, endoplasmic
Secretory vesicles	autism spectrum disorders, 1015–1016	reticulum membrane, 122f, 126
biogenesis, 134–135	behavioral arousal/activity, 311–312	Signal transduction
neurotransmitter release, eukaryotic cells,	chemical structure, 301f	histamine H <sub>4</sub> receptor, 334–335
237–238, 237f	circadian rhythm modulation, 312	myelin sheaths, 577–578
synaptic vesicle trafficking, presynaptic terminal, 139	feeding behavior and food intake, 312–313 indolealkylamine 5-hydroxytryptamine	protein phosphorylation cascades, 469f TrkB/BDNF-mediated neuronal survival
Seizure disorders. See also Epilepsy	identification, 301	and differentiation, 502–503f
hereditary folate malabsorption, 749	monoamine oxidase oxidative	SLC1A1-4 gene, glutamate symporters, 53–54
lipid mediator pathways, platelet-	deamination, catabolic pathway	SLC1A6 gene, glutamate symporters, 53–54
activating factor, 651f, 652	regulation, 310–311	SLC1 proteins, glutamate symporters, 53
membrane lipid breakdown, 654–655	neuroanatomical organization, 301–304,	SLC6 symporter subfamily, amino acid
nonketotic hyperglycinemia, 744–745	302f, 302t, 303f, 304f	transmitters and biogenic amines,
phospholipases A <sub>2</sub> , arachidonic/	neuroendocrine function, 312	52–53
docosahexaenoic acid release, 647	receptors, 313–321	SLC25A12 gene mutation, N-acetylaspartate
phospholipid targeting, synaptic membranes, 645	5-HT <sub>1P</sub> receptor, 320–321	formation, myelination and brain
Self-renewing stem cells, 558–559	5-HT <sub>1</sub> subfamily, 314–317, 315t 5-HT <sub>1A</sub> receptor, 314	function, 212–213, 212f Sleep disorders
Semantic memory, 965	5-HT <sub>1B</sub> receptor, 316–317	depression and, 987
Semilunar ganglion, pain management, 929	5-HT <sub>1D</sub> receptor, 316–317	GABAErgic neurotransmission, 991
Semiochemical detection, vomeronasal organ,	5-HT <sub>1E</sub> receptor, 317	hypocretins and, 990
910	5-HT <sub>1F</sub> receptor, 317	insomnia, 995–996
Serine	5-HT <sub>2</sub> subfamily, 317–318	medicine and neurobiology, 984-986
AQP4 regulation, serine phosphorylation, 58	5-HT <sub>2A</sub> receptor, 317–318	pain and, opioid-induced sleep disruption,
glycine precursor, 250	5-HT <sub>2B</sub> receptor, 318	adenosine and, 993–994
nonketotic hyperglycinemia and, 744	5-HT <sub>2C</sub> receptor, 318	restless legs syndrome, 989
phosphorylation cell regulation, 467–470, 468f	5-HT <sub>3</sub> receptor, as ligand-gated ion channel, 318–319	Sleep regulation adenosine, 993–994
G protein function and, 418	5-HT <sub>4</sub> receptor, 319–320	amino acids, 990–993
human kinome, 471f	5-HT <sub>5</sub> receptor, 320–321	ATP-adenosine signaling, glial cells, 385–386
myo-inositol in cells, 449	5-HT <sub>6</sub> receptor, 320	brain energy metabolism, 983f
neuronal phosphoproteins, 482-484, 483f	5-HT <sub>7</sub> receptor, 320	dopamine and, 988–989
phosphodiesterase regulation, 437	mental illness and 5-HT <sub>1A</sub> , 316	functions, 983-984, 983f
protein kinases/phosphatases	subtype definition, 313–314	future research issues, 994, 994f
antagonistic actions, 468–470, 471f	subtype research, 314	glutamate neurotransmission and, 991–992
CREB transcription factor, 488f, 489	serotonin transporter, acute and chronic	histamine, 987
extrasynaptic mechanisms, 489	regulation, 309–310	hypocretins/orexins, 989–990
hereditary neuronal disorders, 474t, 489–491	sleep regulation, 986–987 synapse termination, 308–309, 310f	monoamines, 986–987 neurochemical substrates, 983–986
neuronal functions, 481–482	synthesis conditions, 306	neurotransmitters, 984, 985f
postsynaptic mechanism regulation,	vesicle storage and exocytotic release,	norepinephrine, 986
487–489	306–308, 307f, 308f	Parkinson's disease, 989
presynaptic mechanism regulation,	volume and paracrine neurotransmission,	serotonin, 986–987
485–487, 485f	311	stress and

induced pluripotent cell reprogramming

Slow channel syndrome, 790 mechanisms, 42-43, 42f and differentiation, 562-563 plasmalemma regulation, 45, 46f leukodystrophies, enzyme/protein Slow component a (SCa), slow axonal transport, 155 signaling microdomain scaffolds, 48 replacement, 564 Slow component b (SCb), slow axonal sodium-calcium antiporters and calcium multiple sclerosis, immunomodulation, 566 transport, 155 pumps, 55, 56f multipotent and self-renewing, 558-559 Slow potentials, excitable cell electrical trafficking regulatory factors, 46 in nervous system, 558 signals, 65-66 Sodium pump, catalytic gamma subunits, nervous system repair, 563-567 44-45 Small G proteins, 418-419, 418t neural stem cells, 560, 560f, 561f Rab family, 419, 419f Soluble adenylyl cyclase, expression and neuron and glial development, 559-561 Ras proteins, 418-419 regulation, 328 Parkinson's disease, neurochemical Smell. See Olfaction Soluble guanylyl cyclases, 432-433 replacement, 563-564 Smooth endoplasmic reticulum (SER), Soluble N-ethyl-maleimide sulfhydryl factor peripheral nervous system, neural crest biosynthetic secretory pathway attachment protein receptors stem cells, 560-561 membrane-associated polysomes, 126-127 intracellular membrane trafficking, target radial glial stem cells, 560 protein folding, covalent sugar addition, membrane recognition, 125 therapeutic applications, 566-567 126, 127t neurotransmission exocytosis, synaptic Stereocilia actin, hair cell molecules, 921-923 Smooth endoplasmic reticulum calcium vesicle trafficking, 139-142 Stereotyped action potentials, excitable cell (SERCA) pumps Spastin, microtubule organization, 106 electrical signals, 65-66 basic properties, 48-50 Spatiotemporal integration, cyclic Store-operated channels (SOC), calcium ions, sarcoplasmic reticulum, 48 nucleotides, 438-439 structural data, 48-50 Spectrin endoplasmic reticulum signaling, 460 neuronal and glial morphologies, 109 Smooth muscle, serotonin effects, 301 Stress Snake venom, muscle excitation alteration, protein-lipid binding, 29, 30f anxiety disorders, 1032 796-798 Spectrin-ankyrin network autism spectrum disorders, response SNARES. See Soluble N-ethyl-maleimide brain injury pathology and, 37 systems, 1015 brain function, 945-946, 947f sulfhydryl factor attachment membrane-organizing cytoskeleton and, protein receptors 34-35, 35f allostasis and allostatic overload, 951 SNCA gene mutation, familial Parkinson's Sphingolipids, long-chain aminodiol behavioral effects, 950-951 disease, 831 sphingosine backbone, 85-89, 89f future research issues, 953-954 Social communication, olfaction and, 909-910 Spinal cord, pain transmission, 930-931 hippocampus, 946-947 Spinal cord canal, ependymal cells in, 16, 16f Sodium-calcium antiporters, 48 modern life factors, 951-953 Spinal cord imaging, glycine receptor sodium-potassiumneurogenesis and, 959-960 adenosinetriphosphatase distribution, 252 prefrontal cortex and amygdala, 949-951 subunits, 55, 56f Spinal cord injury, fiber growth and research and definitions, 946-947 Sodium-dependent D-glucose symporter regeneration, 592 sleep and circadian rhythms and brain capillary endothelial cell and neuron Spinal interneurons, nociceptive pain, stress axis, 946 930-931 expression, 52 stress hormones, 946 glutamate clearance, 361-362 Spinal nerves, pain management, 929 mood disorders and, 1026 Sodium-dependent glutamine transporters, Spinocerebellar ataxias sleep regulation, norepinephrine, 986 astrocyte to neuron glutamine ataxin-1 protein association, 849 Stress hormones, brain function and, 946 transfer, 362 ataxin-7 protein transcription, 849 Stroke penumbra Sodium-hydro-carbon symporter, docosanoid protection, 635-638 Splice variants, glutamate receptor heterogeneity, 354-356 intracellular pH in brain, 56 focal cerebral ischemia, 622-623, 622f, 623f, Spreading depression, brain injury, ischemic Sodium-hydrogen antiporter, intracellular 624f, 625f, 626f pH in brain, 56 phase, 627 microglial sensors, 618 Sodium ion channel Src family, tyrosine kinase structure, 499f translational targeting, 639, 639f epileptic anti-seizure drugs, 711, 711f Startle disease, molecular genetics and Structural compensatory plasticity, neonatal FMRF-amide-gated sodium ion channel, pathphysiology, 253 brain damage, 590 Stathmin, microtubule organization, 106 [3H]Strychnine, glycine receptor distribution, peptide expression, 402 hyperkalemic periodic paralysis and Status epilepticus model, temporal lobe congenital paramyotonia, 790-791 epilepsy, 708 Subacute sclerosing panencephalitis, immune neurotoxin labeling and cDNA cloning, Stem cell potential, transcription factor functions and, 607 69-71, 70f ectopic expression, 527-528, 527f Substance P at Nodes of Ranvier, 67 anxiety disorders, 1033 Stem cells gene splicing, 399-400, 401f antigenic and functional identification, pain management, 930 mood disorders, 1025 single gene family, 75 561-563 Sodium-potassium-adenosinetriphosphatase nervous system markers, 561, 562t neuropeptide receptors, 400-401 (Na,K-ATPase) neurosphere functional assay, 561-562, 562f Substantia nigra, Parkinson's disease, 831f cardiotonic steroid signal receptors, 46-48, brain neoplasms, 562 Substrates cell replacement therapy, 564-565 brain energy metabolism, 203-204, 47f 219-220 dysmyelinating diseases, 565 catalytic subunits, molecular structure, 43, embryonic stem cells, 559 mitochondrial disease, utilization defects, cerebral energy production, 45 growth factors and guidance cues in, 775-776 development, aging and dementia patterns 565-566 protein phosphorylation, kinase/ hematopoietic stem cells, 559f, 559 phosphatase antagonism, 468-470

heterodimer structure, 43

Sleep-wake cycles, histamine and, 337, 338

Succinic semialdehyde dehydrogenase postsynaptic gene mutations, 253-254 missense mutations, 837-838, 838f deficiency, 753 presynaptic glycine transporter 2 mutation, progressive supranuclear palsy, Sulfur amino acid metabolism disorders, corticobasal degeneration and 745-749, 746f startle disease molecular genetics, 253 Pick's disease, 836 Sumoylation, polyglutamine repeat diseases, inhibitory/excititatory disruption, epilepsy, research background, 829-830 706-708, 707f transgenic mouse models, 820-821 Superoxide dismutase, type 1 mutations metabotropic glutamate, 358-359 Tau protein Alzheimer's disease, 835-836 amyotrophic lateral sclerosis, 803, 807 neuroendocrine cells, regulated secretory pathwya, 245 molecular mechanisms, 808-809 neurofibrillary tangles, 818-819 redox signaling and, 810 neuromuscular junction, 238-239, 240-241f transgenic mouse models, tauopathies, transgenic mice studies, 809 neurotransmitter release, eukaryotic cells, 820-821 wild-type SOD1 misfolding, familial 237-238 axonal and dendritic cytoskeleton amyotrophic lateral sclerosis, neurotransmitter replenishment, vesicle organization, 111 809-811 recycling, 245 cytoskeleton alterations and, 114 Supply-demand relationships, brain energy presynaptic events, 241-245, 243f, 244f frontotemporal dementia genetics metabolism, 205-207 Synaptic vesicles tau-negative FTLD, 726-727 Synapses acetylcholine packaging, 261-262 tau-positive FTLD, 726 cell adhesion molecules, cooperative anterograde fast axonal transport, 153 hyperphosphorylation, filamentous tau, regulation, 175-177, 176f, 177f axonal transport and neurodegeneration, 161 835-836 glutamate symporter failure, 54 catecholamine release, 288 isoforms, in brain, 834-835, 835f nervous system development and catecholamine storage, 288 microtubule association, 834-835 formation of, 543, 544f glutamate accumulation, 346 paired helical filament, 835 structure and function, 10-11, 10f intracellular membrane trafficking, 139-144 pathological development, 836 tyrosine phosphorylation, 509-511 future research issues 143f, 142 phosphoprotein chemistry, 835 Synaptic clefts, neurotransmitter recovery, life cycle, 141f seeding and transmissibility, 883-884 signaling molecule scaffolds, 840 neurotransmitter sodium neurotransmission exocytosis, 139-142 symporters, 52, 53f neurotransmission release 143f, 142 synthetic filaments, 838, 839f Synaptic membranes, phospholipid targeting, presynaptic terminal organization, Tay-Sachs disease, 759-760 secretion/recycling optimization, T-cell activation Synaptic plasticity 139, 140-141t CNS immune activity, microglia addiction and, 1051-1052 protein phosphorylation, 450f ineffectivity, 606 adenylyl cylcase molecular targeting, Synaptosomes, brain energy metabolism major histocompatibility complex, 330-331 neuroimmunology, 599-601, 600f assays, 226 apoptosis and caspase and, 675 Synucleinopathies PAMP and DAMP signals, 602 cannabinoid addiction, 1046-1047 animal models, 833-834 TDP-43 gene, amyotrophic lateral sclerosis, cGMP signaling, guanylyl cyclase diseases, 830t 804 - 805Temporal lobe epilepsy (TLE), kindling receptors, 434 future research issues, 834 model, 708 cyclooxygenase-2 participation, 652-653 research background, 829-830 learning mechanisms, Hebb's rule, 965-966 Synucleins Temporal lobe system, memory function and, long-term depression and receptorα-synuclein 964-965, 964f independent forms, 968 pathology, 832 Temporal specificity, learning and synaptic synthetic filaments, 833, 833f protein phosphorylation 484-489, 479t plasticity, 966 Synaptic transmission, 235-245 classification, 830, 831f Tetraspan proteins, myelin sheath, 194–195 calcium ions, role in, 239-241, 243f lipid-binding proteins, 830-831 Thalamus, pain management, 931-933 multiple system atrophy, 833 Therapeutic targeting chemical transmission between nerve cells, 235-237, 236f Parkinson's and Lewy body diseases, myelin formation and stability, 701-702 831-833, 831f, 832f, 833f nicotinic acetylcholine receptors, 273-274 epilepsy antiseizure drugs, GABA-mediated seeding and transmissibility, 883-884 Threonine, phosphorylation inhibition, 711–712, 712f cell regulation, 467-470, 468f axonal/dendritic sprouting, excitatory G protein function and, 418 Tachykinins, 391-392, 391f synaptic transmission, 709 human kinome, 471f inhibitory/excitatory synaptic input Tardive syndromes, drug therapies, basal myo-inositol in cells, 449 abnormalities, 709 ganglia disorders, 868 neuronal phosphoproteins, 482-484, 483f exocytosis research, 237f, 238 Taste, olfaction mechanisms, 911-914, 912f phosphodiesterase regulation, 437 quantal analysis, 239, 242f cranial nerves, 912 protein kinases/phosphatases glycinergic neurotransmission and G-protein-coupled receptors, 912-913 antagonistic actions, 468-470, 471f neurologic disease, 250-255 G-protein-coupled signaling cascade, CREB transcription factor, 488f, 489 glycine biochemistry and transport, 250 913-914 extrasynaptic mechanisms, 489 glycine receptor distribution, 252-253 ion channel interaction, salts and acids, 914 hereditary neuronal disorders, 474t, 489-491 glycine receptor structure and function, receptor cells, 912 neuronal functions, 481-482 251-252 postsynaptic mechanism regulation, 487-489 Tauopathies animal models, 838-841, 838f H<sup>+</sup>-dependent vesicular transporter, 250 presynaptic mechanism regulation, ligand-gated chloride channel, glycine diseases, 830t 485-487, 485f inhibition, 250-251 FTD mutations, 836, 837f synaptic plasticity and memory functions, postsynaptic effects and pharmacology, future research issues, 841 484-489, 484t 250-251 MAPT mutations, 836-837 protein Ser/Thr kinases, 470-479

distribution, substrate specificity and Transcriptome, cellular phenotype, 528 glutamate-glutamine metabolism, 220 regulation, 470-473, 472f malate dehydrogenase, in cytoplasm and Transducin MAPK cascade, 476-478, 476f conformational activation, 895f, 896f mitochondria, 217 second messenger-dependent proteins, identification of, 412 mitochondrial heterogeneity, 219-220 473-476, 474t signal transduction mediation, 414 multifunctionality, 215-217 second messenger-independent proteins, Transforming growth factor-β1, phosphocreatine, ATP regulation, 218 476, 478–479 neuroinflammation and, 614 pyruvate dehydrogenase complex, glucose oxidation, 217 protein Ser/Thr phosphatases, 479-482, Transgenic mice Alzheimer's disease models, 820-821 glutamate derivation, 343-344, 344f, dual-specificity phosphatases, 481 novel therapy development, 822-823 345-346 protein phosphatase-1, 479-480 familial amyotrophic lateral sclerosis, Trigeminal nerve, pain management, 929 dynactin p150<sup>Glued</sup>, 808 protein phosphatase-2A, 480 Tripartite synapse protein phosphatase-2B, 480-481 learning research, 970f gliotransmitter and modulation, calcium protein phosphatase-2C, 481 motor neuron disease models, 807 signaling, 462-463, 463f schizophrenia and, 1006f Thromboses, homocystinuria and risk of, 747 NF gene mutations, 808 Thyroid axis, mood disorders, 1024-1025 tubulin-specific chaperone mutations, 808 Triplet repeat neurodegenerative disorders, Thyroid diseases, peripheral neuropathy, 684 muscarinic cholinergic receptor, in vivo genetics, 729-730 Tight junctions (TJ) subtype assessment, 277-278 Trk receptors, 552, 552f central nervous system homeostasis, 16-17 nicotinic acetylcholine receptor research, Trophic factors cerebral capillaries, 18 271-272 acetylcholinesterase, 266 spectrin-ankyrin network, cytoskeleton, tauopathy models, 838-841, 838f, 839f retrograde axonal transport, 153-154 34-35 Transglutaminase inhibition, polyglutamine L-Tryptophan, serotonin precursor, 304-306 Tissue injury, pain management, 934 repeat disease therapy, 852-853 TUBB3 syndromes Toll-like receptors, neuroinflammation, Trans-Golgi network congenital fibrosis of extraocular muscles 612-613 biosynthetic secretory pathway 3, 115 microtubule organization, 104-105 Toxicology lysosomal protein sorting, 132 acetylcholinesterase inhibitors, 265-266, organelle polarization, 129 Tuberomamillary region, hypothalamus, plasma membrane protein sorting, 131-132 histaminergic fibers, 324, 326f ADP-ribosylation, G protein modification, protein and lipid transport, 130-131, 131f Tuberous sclerosis bacterial toxins, 419-420 intracellular trafficking convergence, G proteins and, 421 calcium signaling and ischemia, 464 lysosomal convergence, 132 nervous system development, 540 demyelination, animal studies, 697 β-III Tubulin mutations. See also TUBB3 secretory vesicle biogenesis, 134-135 Translation neuroscience, mediator motor neuron disease syndromes copper oxidative toxicity, 809 lipidomics, 659, 659f congenital fibrosis of extraocular muscles SOD1 mutations, 808 Transmembrane domains (TMDs) 3, 115 myelin formation and stability, 701-702 cholesterol synthesis and, 32-33 Tubulin mutations peripheral neuropathies, 687 intracellular signaling, 29, 30f neurological disease, 115 tubulin-specific chaperone E mutations, Toxoplasmosis gondii, neuroimmunology, membrane proteins, 28-29, 29f 598-599 neuropeptide receptors, 400-401, 401f Transcription receptor protein tyrosine kinase, 498-501 Tubulin-specific chaperone E (TBCE), chromatin immunoprecipitation assay, receptor protein tyrosine phosphatases, 505 microtubule organization, 518-520, 521f Transmembrane signaling, heterotrimeric G 104-105 proteins, 411-412 Tyrosine, phosphorylation, 493, 494f co-regulators, chromatin modulation, 516 acetylcholine receptors, 510, 510f gene expression, 516f Transmembrane topology glutamate receptors, 354 histone acetylation, 516, 517f GABA receptors, 511 histone and DNA methylation, 517-518 guanylyl cyclases, 431-432, 431f neuromuscular synapse, 509 Huntington's disease and, 519 Transmissible mink encephalopathy, 874 neuronal development, 505-508, 508f process, 514-518, 515f, 516f Transport vesicles NMDA receptors, 510-511 intracellular membrane trafficking, 120 protein tyrosine kinases, 494-501, 495f transcription factor regulation, 518-521 enzyme domains, 494-498, 496f, 497t, 498f, Transcription factors budding process, 65 addiction and, 1051 cargo unloading, membrane fusion, 125 cAMP regulation, 524-527, 524f, 525f, 526f dynamin protein targeting, 123-124 pleiotropic receptor mutations, 507 response element-binding protein, 525 membrane potential production, 65 receptor domains, 498-501, 500f transgenic organisms, 525-526 Transsulfuration pathway, sulfur amino acid RPTK activation, 500, 500f cellular phenotyping, 527-528, 527f metabolism disorders, 745-746 RPTK inactivation, 500-501, 501f transcriptome regulation, 528 Trauma, necrosis and, 672 RPTK phosphorylation, 501, 502-503f corticosteroid receptors, 522, 522f Tricarboxylic acid (TCA) cycle protein tyrosine phosphatases, 501-505, drug development and targeting, 528-529 brain energy metabolism, 215-219, 216f ectopic expression, 527-528 acetyl coenzyme formation, 218-219 cysteine residue, 503-504 glucocorticoid/mineralocorticoid astrocytic pyruvate carboxylation, 218 dual-specificity phosphatases, 505, 506f RPTPs, 504f, 505 receptors, 521-524, 523f ATP regulation, 217–218 citrate multifunctionality, astrocytic synapse formation, 509–511 NextGen sequencing, 520-521 voltage-gated ion channels, 511 oligodendrocyte specification and synthesis and release, 218 differentiation, 571-572 cycle rate, 217 Tyrosine hydroxylase structure, 520f electron transport chain, ATP production, catecholamine regulation, 284-285, 285f transcription regulation, 518-521 protein phosphoregulation, 483, 483f

#### U

Ubiquitin-proteasome system, polyglutamine protein turnover, 846–847 Urea cycle defects, 749–752, 749f cognition and, 752 Uremia, peripheral neuropathy, 684

#### V

 $m V_0V_1$  proton pumps, Golgi-derived organelles, 50, 50f Valosin-containing protein (VCP), amyotrophic lateral sclerosis, 806 Varenicline, nicotine addiction, 273–274 Vascular endothelial growth factor, blood vessel growth and permeability, 808

Vascular permeability,  $A_{2B}$  receptor regulation, 384

Vasculitic neuropathies, 684–687

Vasopresssin

diabetes insipidus and, 404 identification, 390–391

Ventral tegmental area (VTA) alcohol addiction and, 1049 nicotine addiction, 1048–1049

Vesicle-associated protein-binding protein (VAPB), familial amyotrophic lateral sclerosis, 804

Vesicle coating, intracellular membrane trafficking, transport vesicles, 65

Vesicle recycling

catecholamine release, 288 synaptic transmission, neurotransmitter replenishment, 245

Vesicle storage, serotonin, exocytotic release and, 306–308, 307f, 308f Vesicular acetylcholine transporter (VAChT),

synaptic vesicles, 261

Vesicular glutamate transporters (VGLUTs), glutamate accumulation, 346 Vesicular monoamine transporters (VMATs),

catecholamine storage, synaptic vesicles, 288, 289t

Vestibular systems balance, 923–926

hair cells, 918-923

Video imaging, fast axonal transport, 151 Visual system

brain development, 891–892

calcium ion channel regulation, light stimulation, 894–895

cone phototransduction, 895–897 optic nerve, ganglion cell axons, 890–891 photoreceptor downstream signaling, 897–898

photoreceptors and phototransduction, 892–897, 892f, 893f, 894f

phototransduction molecule recycling, 898–899, 898f

retinal neurodegeneration, 899–900 molecule-directed therapies, 900 retinal sublayers, 890

structure and development, 889–892, 890f Vitamin deficiency, peripheral neuropathies

and, 687

Voltage-gated ion channels alcohol addiction and, 1049 antiseizure drugs, sodium channels,

neuron firing regulation, 711, 711f calcium channels, neurotransmitter receptors, G protein coupling,

413–414 gene family diversity, 76–77 macromolecular complexes, 67–68 mechanisms, 66, 67f

moving charges, 73f, 74

protein component conformation, 68, 69f sodium channels, pain management, 930 superfamily, 69–71, 76t calcium channels, 71, 72f potassium channels, 71 sodium channels, 69–71, 70f tyrosine phosphorylation, 511 Voltage-operated channels (VOC), calcium ions, 457f

Volume transmission, serotonin, 311 Vomeronasal organ

chemosensing system, 910, 911f sensory neurons, 911

Von Gierke disease, 771

### W

Wakefulness

acetylcholine and, 987–988 adenosine regulation, 993 GABA effects on, 991 glutamate neurotransmission and, 991–992 histamine, 987 hypocretins and, 990 neurochemical substrates, 983–984 neurotransmitters, 984, 985f

norepinephrine, 986 Wallerian degeneration peripheral nervous system 584f, 583 peripheral vs. central nervous system, 584t

Water diffusion aquaporins and, 56–58 neuronal extracellular clearance, 58 White matter pathology, diffusion tensor imaging, 196–197

## Z

Zinc, in glutamatergic vesicles, 346 Zonal expression, olfactory receptors, 907