

Index

A

- Adenosine 5'-triphosphate (ATP), 274, 276, 278–280
- Adherens junctions (AJs) in epithelial cells, 185–186, 428–429
- Adhesion molecules, 7, 23, 26–27, 39, 59–60, 66–67, 70–72, 98, 107, 130–131, 159–160, 178, 201, 223–224, 231, 235–237, 242–243, 347, 368, 375, 377, 380, 428, 430–431
- Agrin, 43, 50, 52–54, 57, 60–62, 68, 71, 96, 273–275, 352, 391, 407–410, 412, 415–416
- alternative splicing and activity, 400–401
 - cholinergic transmission, antagonistic role of, 402–403
 - in CNS
 - inter-neuronal synapse formation, 412
 - in ECM, 400
 - postsynaptic sites and, 401–402
 - protein structure and synaptic association, 399
 - signal transduction
 - MuSK activation, 401
 - in vitro* AChR clustering, 398–399
- Alpha-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid (AMPA), 130, 171, 349, 358
- AMPA-receptors (AMPA), 94, 98, 256, 274, 283, 390
- and glutamate release, 310–311
 - receptor-mediated EPSCs, 358
 - type receptor, 390–391
- Alternative splicing, 18, 147, 207, 210–211, 265, 269, 351, 353, 361, 399–400
- AMIGO proteins and neurite outgrowth, 375
- γ Aminobutyric acid (GABA), 87–88, 90, 125, 130, 279, 308, 318, 352, 359
- GABAergic synapses, 147, 251, 256, 328–329, 349, 353, 357–358, 360
- Ankyrins adaptor proteins, 247, 258
- synaptic maintenance and functionality, 25
- Anterior corner cell (aCC), Caps expression in, 15
- Aplysia californica*, ApCAM expression, 266
- Arcadlin as cadherin-like molecule, 165, 177–178
- Artificial synapse formation assays for neurexin–neuroligin splice code, 355–356
- Asperger syndrome, 143, 145–146, 359–360
- See also* Autism spectrum condition/disorder (ASC/ASD)
- Attention-deficit hyperactivity disorder (ADHD), 145
- Autism spectrum condition/disorder (ASC/ASD), 142, 347, 359
- Autism Genome Project Consortium, 146
 - CNTN/CNTNAP* pathway and, 149
 - CNTN3/CNTN4* as susceptibility gene for, 148
 - CTNAP2* mutations, 148
 - neurexins, gene polymorphisms in, 359–361
 - neuroligin genes, 143
 - polymorphisms in, 359–361
 - NLGN* point mutations/deletions, 143–145
 - NRXN1* alteration and, 145–146
 - NRXN/NLGN for synaptic specificity, 147
 - SHANK3* genes, 145
 - X-linked ichthyosis (XLI), 143–144

- Axelrod, J., 4, 6
 neurotransmitter degradation by
 enzymes and by surrounding
 cells, 6
- Axons, 91, 114, 118, 166–167
 axotomized β_2m^- /motoneurons, 309
 CAMs and adhesion
 axon–axon, 21
 axon–ECM, 20–21
 axon–muscle, 21
 pruning in CNS, 131
 in cerebellum, 118–121
 in hippocampus, 107–109, 114–118
 in visual system, 121–125
- Axosomatic synapses, 431
See also Synapses
- B**
- Basal lamina at vertebrate NMJ, 39, 43, 49,
 57, 59, 65, 72, 94, 391, 398–399,
 403, 405, 408, 411–412, 415
 glyco-epitopes, 51–52
 molecular composition, 50–51
 role of, 50
See also Vertebrate neuromuscular
 junction (NMJ)
- Bassoon and Piccolo, 89
See also Presynaptic scaffold molecules in
 CNS
- Bernard, C., 40
 studies on effects of paralytic
 neurotoxin, 40
- Bidirectional signaling
 neurexin–neuroligin trans-synaptic
 complex role in, 359
 semaphorins and, 322–323
- Borna disease virus
 functional immune response and, 312
- Bungarotoxin (BTX)
 AChRs within postsynaptic membrane,
 labeling, 42, 45, 56
 and neuromuscular synapse
 elimination, 111
- C**
- Ca^{2+} /calmodulin-activated Ser-Thr kinase
 (CASK), Ca^{2+} and K^+ channels,
 356–357
- Cadherins and protocadherins (CDH/
 PCDH), 18, 94–95, 160–162
 calcium-dependent cell–cell adhesion, 164
 mutations and
 EFMR, X-linked disorder, 151
 Usher syndrome (USH), 150
 role in
 axon targeting, 166–167
 dendrite and dendritic spine
 morphogenesis, 167–168
 synapse formation and maturation,
 168–170
 synapse function and plasticity,
 170–171
 structures of neuronally expressed
 superfamily members, 164
 in synapse remodeling, 199–200
Caenorhabditis elegans, 66, 209, 230, 235,
 248, 266–267, 434
 LAD-1 and LAD-2, 248
syg-1 and *syg-2* genes, 235
 presynaptic terminals in HSN axons,
 localization of, 238
- Capricious (Caps), 15
See also Cell adhesion molecules (CAMs)
- CASK MAGuKs superfamily protein,
 89–90, 189, 201, 243, 349, 356,
 359–360
 CASK gene mutations and FG
 syndrome, 360
See also Presynaptic scaffold molecules in
 CNS
- Catenin, 161, 164
- Cell adhesion molecules (CAMs), 7, 16, 20,
 22, 32, 64, 91, 93, 108, 130, 141–143,
 152–154, 201, 214, 224, 247,
 249–254, 256–258, 273–275, 279, 373
 aplysiaCAM (apCAM), 266, 269, 272,
 277, 284–285
 components of synaptic connections, 7
 expression pattern at embryonic NMJ,
 23–24
 L1-type, 144, 247–258, 273–274, 373–375
 mediated postsynaptic signaling hub,
 29–31
 mediate FORCES, 26–27
 myopodia for navigating motor axons,
 28–29
 and neuromuscular network formation
 postsynaptic cell pattern, 22–24
 presynaptic cell pattern, 20–21
 at NMJ
 capricious (Caps), 15
 connectin (Con), 15–16
 Down syndrome cell adhesion
 molecule, 16

- fasciclin II (FasII), 16–17
 - fasciclin III (FasIII), 17
 - integrins, 17–18
 - mediated intracellular signaling
 - activation, 25–26
 - N-cadherin (N-Cad), 18
 - neuroglian (Nrg), 18–19
 - research work on, 31–33
 - Toll, LRR family of transmembrane proteins, 19
 - in NMJ plasticity, 27
 - polymorphisms and susceptibility, psychiatric conditions, 152–153
 - synaptogenesis
 - function of, 91
 - loss-of-function phenotypes in formation, 95–96
 - two-step model for CAM-mediated NMJ formation, 27
 - See also* Vertebrate neuromuscular junction (NMJ)
 - Cell–cell junctions in neurons, 186, 195
 - Cell surface expression of MHC class I in neuronal subpopulations, 303
 - Central nervous system (CNS), 12–15, 19–21, 29, 71–72, 108, 123, 159–160, 166, 173, 200–201, 223–225, 243, 247, 253–254, 257, 259, 270–271, 275, 301, 303–305, 309–311, 329, 333, 348, 372, 378, 387, 390–392, 408–416, 430, 433
 - synapses, 414
 - formation of, 85, 92, 94
 - molecules at, 87–91
 - ultrastructure, 86–87
 - synaptogenesis in
 - axon with dendrite, contact and differentiation, 91–93
 - maturation and maintenance, 93–94
 - molecules, 94–99
 - Cerebellum, 2, 98, 108, 126, 148–150, 176, 201, 225, 253, 269–270, 311, 348, 414, 432
 - axon pruning in
 - CAMs role in, 121
 - cellular mechanism, 120–121
 - climbing fibers and Purkinje cells, contacts between, 118–119
 - redundant climbing fibers regression, 119
 - Necl-2, expression in, 201
 - Cheerio effect[®], 428–429
 - See also* Gap junctions as electrical synapses
 - Chicken, NCAM1 and NCAM2 expression, 266
 - Classical cadherins/catenins, 161–162
 - type I and II, 164
 - Collagen, 20, 49, 61–62, 67, 274, 398, 406–407, 413
 - collagen IV, 20–21, 49–50, 60, 63–70, 403
 - ColQ proteins and AChE interaction, 407
 - Connectin (Con), 15–16, 23
 - See also* Cell adhesion molecules (CAMs)
 - Connexin (Cx) hemichannels, 8, 424–426, 430–432, 434–435
 - See also* Gap junctions as electrical synapses
 - Connexin/pannexin-containing gap junctions, electrical synapses, 8
 - See also* Gap junctions as electrical synapses
 - Contactin and contactin-associated proteins, 249, 274, 360
 - CNTNAP2* gene, autism susceptibility gene, 360
 - CNTN3* and *CNTN4*, alterations of, 148
 - members of, 147
 - mutations in, 152
 - Contact inhibition, nectins and Necl-5 function, 194
 - Cortical dysplasia-focal epilepsy syndrome (CDFE) and *CNTNAP2* mutations, 148
 - Couteaux, R., 41, 59
 - Cytomatrix at active zone (CAZ)-associated protein CAST, 89
 - Cytoskeleton, 7, 16, 25–26, 32, 55–56, 94, 147, 150, 164, 188, 190–193, 199–200, 209, 215, 243–244, 247–249, 277, 324, 327, 340, 385, 412
 - Cytotoxic T lymphocyte (CTL)
 - axonal lesions, 313
 - mediated immune response, 312
- D**
- Dale, Sir H., 4, 5, 6, 40
 - chemical-centered signal transmission at synapse, view on, 6
 - Deiters, O. F. K., 1

- Dendrite, 91–93, 114–115, 119–120, 159, 169, 197, 220, 224, 236, 339, 341, 356, 379, 390
 spine, 166–168, 196, 309, 327, 329, 340, 392
- de Robertis, E., 6
 Neuron Doctrine, morphological proof of, 6
- Doublecortin, 249, 254
 mutations in neurological disorder, 250
- Down syndrome cell adhesion molecule (Dscam), 16, 95, 154, 207–220, 223–224, 227–232
 branch segregation and self-avoidance, 215–217
 cytodomains of, 210
 family members identification, 208–209
 homophilic interactions, 213
 function, 215
 isoform-specific, 214
 S-shape conformation, 214
- Ig domains and fibronectin type III modules, 209
 isoforms of, 215
 mediated repulsion, 216
 molecular diversity, 210–213
 mRNA expression studies, 212
 mutant neurons, 217
 non-arthropod DSCAM transcripts, alternative splicing, 210–211
 non-DSCAM interactions, 219–220
 non-repulsive functions, 218–219
 PDZ-binding motif, 231
 structural domains of, 229
 tiling, 217–218
See also Cell adhesion molecules (CAMs)
- Drosophila melanogaster*, 11–20, 22–28, 31, 33, 166–167, 171, 174, 176, 178, 209, 213, 216–218, 228–230, 232, 235–236, 240–241, 248, 254–256, 266–267, 269, 271, 276–278, 283, 285, 325, 388, 391, 410, 434
- Dscam* genes, 209, 211
 transcript and protein structure, 212
- Dscam-mediated homophilic repulsion, 215
 embryonic development, 13
 eye patterning, 241
 flamingo mutants and motor axons, 175
IrreC and *Duf* genes, 236
 Kekkon (Kekkon 1–5) protein and, 368
 muscle nomenclature conversion, 14
 myoblast fusion in, 240–241
 nervous system, 12
 neuromuscular junction (NMJ), 12
 CAM-mediated intracellular signaling, 24–26
 and CAMs, 15–19, 32
 as model for studying regulatory mechanisms for mammalian central glutamatergic synapses, 13
 sequence of events, 31
 stereotypic embryonic neuromuscular cellular pattern, 22
 neuromuscular network
 as genetic and cell biological model, 12
 representation of, 14
 self-avoidance in, 215
Volado (Vol) gene, disruption of, 388
 wild type and mutant *nrg*, ultrastructural comparison between, 255
- Dye coupling, 434
- Dystroglycan, 71, 349, 351–352, 400–401, 403–404, 412, 416
 cell surface receptor at NMJ, 409–410
 ECM organization and AChR clustering, 351–352
- E**
- Eccles, Sir J., 4, 5–6, 118
- EFMR, X-linked disorder, 151
See also Cadherins and protocadherins (CDH/PCDH)
- Electrical coupling, 40
 impulse activity, synchronization of, 431
- Elliott, T. R., 5
 mechanism and chemical nature of synaptic signals, 5
- Eph family, 334–335
 Eph receptor, 115–116, 224, 237, 333, 341
 Eph receptor tyrosine kinases (RTKs), 333–334
 axon pathfinding, 336
 family members of, 334
 protein domain organization of, 335
 synapse formation in CNS, 338–341
- Ephrins transmembrane proteins
 axon pathfinding, 336
 diverse projections in developing brain, role in, 115–116
 EphA5 receptor, postnatal development, 116
 overexpression of, 337
- EphB, 98–99, 237
 expression in CNS, 98–99, 115–116

- GPI-anchored ephrins in, 336
 - hippocampal formation and, 116
 - neuromuscular topography and synapse formation in PNS, control, 336–337
 - protein domain organization of, 335
 - synapse formation in CNS, 338–341
 - Epilepsy and *CNTNAP2* alterations, 149
 - Excitatory synapses (type I synapses), 86–87
 - Extracellular matrix (ECM), 7, 72, 125, 193, 249, 265, 274, 352, 385, 391, 397, 416
 - aneural clusters and change, 54
 - brain of, 414
 - CNS synapses, molecules in
 - agrin in, 412
 - laminins in, 412–413
 - proteoglycans, 413–414
 - thrombospondins, 414–415
 - composition of, 398
 - and NMJ formation, 20
 - agrin, 398–403
 - collagens, 406
 - dystroglycan, 409–410
 - growth factors, importance of, 410–411
 - laminins, 403–406
 - matrix components, 406–407
 - proteases, 407–408
 - synapse-specific carbohydrates, 408–409
- F**
- Fasciclin II (FasII), 16–17
 - Fasciclin III (FasIII), 17
 - Fat-like protocadherins single-pass transmembrane proteins, 175
 - Fibroblast growth factor (FGF)
 - FGF22 fibroblast growth factor family and presynaptic differentiation, 98
 - fibroblast growth factor receptor (FGFR), 249, 375
 - mediated signaling cascade, 272
 - Filopodia, 27–29, 31–33, 91–92, 193, 195–197, 216, 378, 428
 - Foster, Sir M., 3, 86, 303
 - Handbook of Human Physiology*, 3
 - Fragile X mental retardation protein (FMRP)
 - fragile X syndrome, 361
 - role in normal synapse maturation and neuronal plasticity, 117
 - Fukuyama's muscular dystrophy, 352, 409

- G**
- Gap junctions as electrical synapses, 423
 - clustering mechanism, 429
 - connexin in, 424–425
 - in development, 433–434
 - dye and electrical coupling, measurements of, 434
 - formation between neurons, specificity, 430
 - mixed synapses, 432–433
 - projection neurons, coupling of, 432
 - types of, 431
 - formation specificity in central nervous system, 430
 - mechanism for, 429
 - new channels, timed labeling of, 426
 - opening of, 427–428
 - multiple channels, dependence on, 428
 - pannexins/innexins, 434
 - functional differences, 435
 - as sites of attachment, 428–430
 - small central areas, internalization of, 427
 - See also* Synapses
 - Gary, G., 86
 - Gray type I and Gray type II synapses, 86
 - synaptic contacts between neurons in CNS, evidence of, 86
 - Gephyrin scaffold protein, 90–91, 97, 253, 356
 - See also* Postsynaptic scaffold molecules in CNS
 - Gilles de la Tourette syndrome and *CNTNAP2* alterations, 149
 - Glutamatergic synapses, 11, 13, 33, 89, 121, 146–147, 252, 256–257, 306, 308–312, 315, 328–329, 353, 358, 360, 433
 - Glycosylphosphatidyl inositol (GPI), 147–148, 169, 249, 265, 268–269, 271, 273, 279, 284, 322, 335–336, 407
 - GPI-anchored ephrins in cholesterol-rich microdomains in cell membrane, 336
 - GPI-anchored isoform of Xenopus NCAM2, 271
 - Glycosyltransferase genes and human diseases, 409
 - Golgi, C., 1, 2, 3, 4, 5, 8, 414
 - histological staining procedure, 2
 - Nobel Prize for physiology/medicine, 3
 - Reticular Theory, 1
 - Growth cone, 16, 21, 28–29, 32, 52, 55, 59, 91, 96, 322, 324–325, 336, 367, 379–380

H

- Hebbs, D., 112, 126, 129
- Heparan sulfate proteoglycan (HSPGs), 403, 407, 414
- agrin, 399
 - BL of vertebrate NMJs, 49, 60, 63, 67
 - and fibroblast growth factors (FGFs), 410–411
 - NCAM and, 377
- Heterodimeric ($\alpha\beta$) transmembrane receptors, 385
- Hippocampus, 92, 114, 116–117, 120, 126, 169–170, 195–198, 200, 225, 251–253, 269–270, 275, 278, 281–283, 286, 304, 306, 310–312, 315, 326–327, 338–340, 348, 355, 387, 392
- CA1 and CA3 cells in neurexin gene expression, 351
 - and cerebellar axon pruning, 115
- His, W., 1, 2, 3, 4
- dendrites term for cytoplasmic neuronal processes, 3

I

- Immunoglobulin (Ig) superfamily proteins, 17, 94, 97, 147, 166, 208, 223, 229, 247, 273, 387
- Ig domain, 187, 190, 207, 209–214, 244
- Inner plexiform layer (IPL), 19–20, 25–29
- Innexins, 424, 434–435
- Integrins, 17–18, 385
- at CNS synapses
 - dendritic spines, 390–391
 - and memory, 388–389
 - neurotransmitter receptors and, 389–390
 - pharmacological and genetic manipulations, 388
 - synaptic plasticity, 387–388
 - heterodimer, representation of, 386
 - in NMJ synapses, 391
 - functions for, 392
 - synaptic neuropathology, role of, 392
 - See also* Cell adhesion molecules (CAMs)
- Invertebrate semaphorins and synapse development
- giant fiber motor neuron (GF-TTMn) synapse, 325–326
 - Sema-1a, role of, 325–326
- IrreC/Nephrin/SYG-1 family of adhesion molecules, 235

- L1-syndrome, 250
- phylogenetic analysis of, 236
- SYG-1* and *SYG-2* as synaptic target of HSNL neuron in *C. elegans*, 235–240

K

- Katz, Sir B., 4, 6, 41
- neurotransmitter molecules from presynaptic termini and, 6
- Killer cells
- killer cell activating receptor-associated protein (KARAP), 311–312
 - killer cell immunoglobulin-like receptors (KIR), binding partners for MHC class I molecules, 311
- Kühne, W., 40
- studies on NMJs as sites of neurotransmission, 40

L

- Laminins, 39, 62, 71, 403–405, 412–413
- in CNS, 412–413
 - composition of, 403
 - functions of, 405
 - pre and postsynaptic specializations, 405–406
 - specificity, 224–230
 - structure and synaptic association, 404
- Langley, J. N., 5
- mechanism and chemical nature of synaptic signals, 5
- Lateral geniculate nucleus (LGN), cellular and subcellular expression of MHC class I in, 306
- α -Latrotoxin (α -LTX) and neurexins search, 347–348
- Leech, LeechCAM expression, 266
- L1 syndrome, 143, 250
- Leucine rich repeat (LRR), 19, 367–369, 373, 375–376
- Leucocyte immunoglobulin-like receptor (LILR) and Ly49, MHC class I antibodies, 306
- Lissencephaly gene-1 (*LIS-1*) mutations in neurological disorder, 250
- Loewi, O., 4, 5, 40
- signaling across synapses, experiments on, 5
- Long-term potentiation (LTP), 387–388

- L1-type cell adhesion molecules (L1-CAM),
 144, 247–258, 253, 273–274, 373–375
 FIGQY-motif in, 254
 L1-syndrome, 253
 structure, 247
 synaptic functions
 learning and memory, 250–252
 in synaptogenesis, 253–256
 targeting, 252–253
 transmission and signaling, 257
- Lymphocytic choriomeningitis virus (LCMV)
 functional immune response and, 312
- Ly-49 receptor, inhibitory and activating
 effects in immune system, 311
- M**
- McMahan, U. J., 59–61, 398
 The Agrin Hypothesis, 398
- Major histocompatibility complex class I
 (MHC class I), 123
 assembled in ER by transporter
 associated with antigen processing
 (TAP), 302
 deficiency of, 306–308
 dependent immune-mediated
 cytotoxicity, 303
 dependent synapses in nervous system
 and immune system, 309
 expression and regulation, *in vitro* and
 in vivo studies, 303
 tetradotoxin (TTX) and IFN- γ
 treatment, 304
 function of, 302
 neurological diseases and, 314–315
 nonsynaptic functions
 neuronal susceptibility and immune-
 mediated cytotoxicity, 312–313
 vomeronasal organ, 313–314
 signaling, 309
 structure, 301
 synaptic functions
 in axotomized spinal cord, synaptic
 elimination, 307–309
 expression in neurons, 302–303
 putative neuronal class I receptors,
 310–312
 surface expression, 305–306
 synaptic plasticity in developing and
 adult brain, 306–307
- Manduca sexta*, transmembrane fasciclin
 II form by neuronal cells in
 CNS, 269
- Membrane-associated guanylate kinase
 (MAGUK) proteins, 188, 256,
 356, 367, 372
 in assembly and organization of cell
 junctions, 89–90
See also Synaptic adhesion-like molecules
 (SALMs)
- Mental retardation, 117, 141, 145, 149–151,
 153, 176, 199, 208, 250, 347, 352,
 392, 408–409, 416
 neurexins and neuroligins, gene
 polymorphisms in, 359–361
- β_2 -Microglobulin (β_2m) polypeptide, 301
See also Major histocompatibility
 complex class I (MHC class I)
- Miniature postsynaptic currents
 (mPSCs), 358
- Mint1 cytoplasmic proteins CASK-
 interacting proteins, 89
- Mossy fibers (MB), 114, 117, 197–198, 351
 and infrapyramidal bundle (IPB),
 synaptic complexes, 115
- Motor axons, 11, 15, 20–21, 28, 42, 44,
 48–49, 52, 54–56, 59–60, 62, 65,
 111–112, 175, 337, 402, 411
 innervation
 multiple muscle fibers within same
 muscle, 45
 muscle by, 45
 muscle-specific kinase (MuSK), role of, 53
 P/Q type calcium channels and, 47
 synaptic vesicle-associated proteins and, 46
- Motor neurons, 12, 16, 52, 55, 60–62, 69, 110,
 237, 269, 284, 336–337, 391, 400,
 402–403, 405, 410–412
 in developing CNS and muscle cell
 targets, 13
 and presynaptic terminals, 44–47
- Mouse hepatitis virus
 functional immune response and, 312
- Munc13-1, 88
See also Presynaptic scaffold molecules in
 CNS
- Muscle-eye-brain disease (MEB), 352
- Muscle-specific kinase (MuSK) as putative
 postsynaptic co-receptor, 43, 50,
 53–54, 67, 70–71, 274–275,
 400–403, 407, 409, 412, 415
 as putative postsynaptic co-receptor,
 53–54, 275, 401
- Myopodia filopodia like structures, 31–33
 CAMs and motor axons, 28–29
 and synaptogenesis, 19, 28

N

- Narp overexpression and clustering of
 AMPA receptors at synapses, 98
- Nasu-Hakola disease, lack of MHC class I
 receptors, 315
- N-Cadherin (N-Cad), 18, 23, 95, 160, 166,
 195–196, 199, 375, 379
See also Cell adhesion molecules (CAMs)
- Nectin and nectin-like molecules (Necls), 95,
 97–98
 AJs and TJs, formation of, 192
 axons and dendrites, selective association
 between, 199
 cadherins and AJs, 190
 CAMs and growthfactor receptor,
 interactions, 193–194
 cell–cell adhesion activity, 189–190
 cell–cell junctions in central and
 peripheral nervous systems,
 200–201
 genetic deletion effect on brain, 197
 induced signaling, 192
 molecular structures and, 188
 nectin–afadin and cadherin–catenin
 system, association of, 191
 properties of, 187
 in synapse remodeling, 199–200
 synapses formation and, 194–199
- Nephrin in kidney development, 235–236,
 241–243
- Neural cell adhesion molecule 1 (NCAM1),
 71, 224
 ectodomains of, 269–270
 extracellular ATP effect on function,
 278–280
 extracellular interaction partners of, 272
 agrin, 275
 chondroitin sulfate proteoglycans
 (CSPGs), 274
 growth factors and growth factor
 receptors, 275–276
 heparan sulphate proteoglycans
 (HSPGs), 274
 Ig1–Ig2 and Ig1–Ig2–Ig3, 273
 muscle-specific kinase (MuSK), 275
 neurocan and phosphacan, 275
 nicotinic acetylcholine receptors
 (nAChRs), 275
 p75 neurotrophin receptor (p75NTR),
 275
 Prion protein (PrP^c), 273
 TAG-1 and L1-CAM, 273
 family members, 266
 function
 extracellular ATP effect on, 278–280
 long-term potentiation and long-term
 depression, 283–286
 polysialic acid regulatory roles on,
 280–283
 intracellular interaction partners
 α -actinin 1, 277
 ATP, 279
 α - and β -tubulin, 277
 cytoskeleton, 277
 cytosolic, 276
 leucine-rich acidic nuclear protein
 (LANP/PHAP-1), 277
 phospholipase C γ (PLC γ), 277
 serine/threonine phosphatases PP1
 and PP2A, 277
 spectrin, 277
 syndapin, 277
 voltage-dependent Ca²⁺ channels
 (VDCC), 277
 mediated intracellular signaling
 pathways, 278
 organization of, 268
 phosphorylation and NF- κ B
 transcription factor activation, 272
 phylogenetic tree, 267
 posttranslational modifications, 271–272
 structure, 268–271
 Walker A motif, 280
- Neurexins, 89, 97, 121, 142–147, 152, 237,
 306, 377
 in brain, distribution of, 350
 cell adhesion and synaptic plasticity, link
 between, 358–359
 dystroglycan and neurexophilin, 351–352
 gene polymorphisms in ASD and mental
 retardation, 359–361
 genes, expression pattern of, 348
 olfactory bulb, 351
 intracellular signaling of, 356–357
 longer α and shorter β isoform, 348
 β -neurexins CASK-interacting
 proteins, 89
 and neuroligins function in
 synaptogenesis, 97
 splice sites of, 348
 splicing of, 353
 neuroligin 1 and neuroligin 3, 354–355
 surface plasmon resonance (SPR)
 experiments, 354
 structure of, 349
in vitro synapse formation assays, 355–356

- Neurexophilin, 351–352
- Neurite outgrowth, 149, 253, 270, 272, 274–280, 368, 372, 375, 377–378
- characteristics, 376
 - PDZ domain proteins, 379
- Neuroadapted Sindbis virus
- functional immune response and, 312
- Neurofascin, 95, 247, 250, 252–254, 256
- Neuroglian (Nrg), 18–19, 23, 248–249, 254, 256
- See also* Cell adhesion molecules (CAMs)
- Neuroligins, 93, 96–97, 121, 142–143, 145–146, 152, 169, 189, 196, 223, 237, 306, 349, 351, 373–375, 377–378
- cell adhesion and synaptic plasticity, link between, 358–359
 - genes
 - polymorphisms in ASD and mental retardation, 359–361
 - and proteins structure, 352–353
 - intracellular signaling of, 356–357
 - and neurexins, 142–147
 - PSD-95-Dlg-ZO homology (PDZ)-binding motif, 357
 - splicing of, 353
 - neuroligin 1 and neuroligin 3, 354–355
 - surface plasmon resonance (SPR) experiments, 354
 - structure of, 349
 - in vitro* synapse formation assays, 355–356
- Neuromuscular junction (NMJ), 23, 32, 39
- chemical neurotransmission, 40
 - development of
 - AChRs clustering in absence nerves and nerve-derived cues, 53
 - aneural AChRs and motor axons, 54–57
 - muscle-specific kinase (MuSK), 53
 - postnatal pruning of supernumerary nerve terminals, 57
 - synaptic differentiation, 52
 - synaptic maturation and maintenance, 57–59
 - fluorescently labeled conjugated bungarotoxin (BTX), 42
 - molecular signals and synapse formation, 41
 - morphology of, 42–43
 - motor neurons and presynaptic terminals, 44–47
 - non-myelinating perisynaptic Schwann cells, 48–49
 - postsynaptic apparatus, 47–48
 - synaptic cleft and basal lamina, 49–52
 - motor axons and nerve terminals, 42
 - quantal and vesicular theories of neurotransmission, 41
 - study of, 39
 - synapses, molecular components of, 40
 - synaptic partners and, 40
 - and trans-synaptic cues, 59
 - agrin, 60–61
 - collagen IV, 63–65
 - growth factors, 68–69
 - laminins, 61–63
 - matrix-degrading enzymes, 67
 - matrix molecules, 66–67
 - nidogens, 66
 - synaptogenic molecules within synaptic BL, 60
 - transmembrane adhesion molecules, 70–71
- Neurons, 195, 236
- Neuropilin, 323
- Nidogen, 66
- NK-cell receptors for MHC class I molecules, 302
- N-Methyl-D-aspartate (NMDA)-type receptor, 94, 99, 170, 189, 252, 256, 277, 281, 339–340, 390
- NMDA receptor-mediated excitatory postsynaptic currents (EPSCs), 358
- Nobel Prizes for physiology/medicine for neuroscience discoveries, 4
- NRXN–NLGN–SHANK pathway at synapses in human brain, 146
- P**
- Paired immunoglobulin receptor B (PIR-B) and MHC class I antibodies, 306
- Pannexins, 8, 424, 434
- pannexin/innexin junctions, 435
- 3p Deletion syndrome, 148
- PDZ protein, 25, 228, 231, 235, 372
- Pecot-Dechavassine, M., 41
- Perineuronal nets (PNNs), neuron's synaptic connections, 414
- Peripheral nervous system (PNS), 12, 19, 108–114, 200–201, 333, 392

- Phosphatidylinositol-specific phospholipase C (PI-PLC) and cleavage of NCAM1, 279
- Plexin A
 - activation and downstream signaling molecules regulation, 324
 - plexin-A3 mutants, 116
- Polynuclear innervation, 68, 110
- Polysialic acid (PSA), 271
 - AMPA receptor-mediated currents and, 283
 - anti-adhesive property of, 282
 - axonal growth and, 282
 - FnIII module, 283
 - learning and memory formation, modulator of, 282
 - NCAM1-associated expression, 281
 - and NCAM1 glycosylation, 280
 - nitric oxide (NO)-cGMP-mediated signaling, 281
 - ST8SiaII expression, 281
 - synthesis of, 280–281
- Postsynaptic densities (PSDs), 86
- Postsynaptic scaffold molecules in CNS
 - gephyrin, 90–91
 - ProSAP/Shank family proteins, 90–91
 - PSD95/SAP90 family, 90
- Presynaptic scaffold molecules in CNS
 - Bassoon and Piccolo, 89
 - CASK, 89–90
 - Munc13-1, 88
 - RIM1, 88
- Proteoglycans, 49–50, 60, 63, 66–67, 273–274, 377, 398, 403, 407, 410
- Protocadherins (Pcdhs), 95, 150–151, 160, 163, 171
 - clustered, 172–174
 - in CNS extracellular matrix, 413–414
 - δ -Pcdhs, 176–177
 - Fat-type and 7-transmembrane, 174–176
 - murine Pcdh- α , Pcdh- β and Pcdh- γ gene clusters, 165
 - See also* Cadherins and protocadherins (CDH/PCDH)
- PSD-95 family of MAGUK proteins, 25, 48, 90, 195–196, 304, 327–328, 335, 349, 356–359, 372
 - dendritic branching, 380
 - See also* Synaptic adhesion-like molecules (SALMs)
- Puncta adherentia junctions (PAJs), 186
- Purkinje cells
 - and climbing fibers for study of synapse elimination, 118–119
 - early postnatal life, 115
 - stochastic pruning in developing cerebellum, 119–120
 - synaptic responses and, 120
- Q**
- Quantal release hypothesis, 41
- R**
- Rab3 acceptor protein PRA1, 89
- Rabies virus
 - functional immune response and, 312
- Ramon y Cajal, S., 1–5, 8, 59, 118, 225–226, 414
 - Neuron Doctrine of nervous system, 3
 - Nobel Prize for physiology/medicine, 3
 - Purkinje and granule cells drawings, 2
 - Reticular Theory, 1
- Rasmussen encephalitis, 303
 - See also* Major histocompatibility complex class I (MHC class I)
- Rb-8-neural cell adhesion molecule (RNCAM), 266
- Reelin ECM protein, 113
 - See also* Synapses
- Remak, R., 1
- Retina
 - activity and BDNF, 124
 - Cad7 and Cad11, role in, 167
 - Ig superfamily molecules and laminar specificity, 227
 - MHC class I proteins and, 123
 - in multiple sublaminae, 225
 - photoreceptor ribbon synapse formation, 89
 - retinal ganglion cells (RGCs), axonal terminals and, 123
 - Sdk1 expression, 230
 - synaptic zones of, 174
- Rett's syndrome (RTT), 145, 314
- RIM1 molecules, 88
 - See also* Presynaptic scaffold molecules in CNS
- Robertson, J. D., 6, 41
 - Neuron Doctrine, morphological proof of, 6
- Ruska, E. A., 6
 - first electron microscope, development of, 6

S

- Schizophrenia and *CNTNAP2* alterations, 149
- Schwann, T., 1
- Semaphorin family, 21, 321–322
 - discovery and organization, 322–323
 - neuropilin and plexin receptors, 116
 - non-plexin-dependent effects of, 324
 - proteins, 323–324
 - pruning of IPB in hippocampus, 116
 - receptors, biological functions of, 324–325
 - semaphorin/plexin complex, 325
 - structures of, 323
 - in synapse formation and function
 - class 4 semaphorins, 328–329
 - class 3 semaphorins (Sema3A), role of, 326–328
- Shank 3* gene in ASD, 145, 360
- Sherrington, Sir C. S., 3, 4, 86
- Sidekick proteins (Sdks)
 - laminar organization of retina, 225–226
 - laminar specificity
 - DSCAMs and, 228–229
 - role in, 224
 - molecular and cellular properties
 - ectodomains and homophilic adhesion, 230–231
 - intracellular signaling, 231
 - structure and expression, 229–230
 - PDZ-binding motif, 231
 - structural domains of, 229
- Silent synapses, 358
 - See also* Synapses
- Sjöstrand, F. S., 6
 - Neuron Doctrine, morphological proof of, 6
- Synapses
 - developmental stages during maturation of, 198
 - elimination
 - AChR territory and, 111
 - activity-based competition process, 112
 - asynchronous firing of motor axons, 112
 - climbing fibers and Purkinje cells, 118–119
 - in developing neuromuscular junction, 110
 - in peripheral nervous system, 109
 - p75 neurotrophin receptor (p75NTR)-mediated axonal degeneration and, 113–114
 - postsynaptic ACh receptors (AChRs) and calcium influx, role in, 112–113
 - reelin, role of, 113
 - formation, 377–378
 - PDZ domain proteins, 379
 - history, 1
 - intercellular junctions between axons and dendrites of neurons, 195
 - stabilization, neurexins and neuroligins, role in, 356–360
 - synaptic clefts, 86
 - at vertebrate NMJ, 49
 - and synaptic delays, 431
 - synaptic junctions (SJs) sites of neurotransmission, 185–186
 - synaptic vesicle (SV), 86
 - synaptogenesis and
 - in CNS, 91–94
 - in HSN axons, 238–239
 - muscle 12 expressing membrane-targeted GFP and RP5 motor axon, 30
 - SynCAM1 protein expression and, 201
 - types of, 431
 - Synaptic adhesion-like molecules (SALMs), 367
 - associated proteins and functional significance, 372
 - dual functions for, 378
 - N-cadherin mediates, 379
 - PSD-95 dendritic branching, 380
 - family sequence comparison, 369
 - homomeric and heteromeric interactions, 373–375
 - multimerization and *cis/trans*-synaptic interactions, hypothetical model of, 374
 - neurite outgrowth, 375, 378
 - characteristics, 376
 - glycosylation, 377
 - PDZ domain proteins, 379
 - phylogenetic analysis, 368
 - protein domain structure, 368
 - species comparison, 371–372
 - synapse formation, 377–378
 - Western blot and subcellular fractionation experiments, 370
- Synaptic plasticity, 387–388
 - activity-dependent, 126
 - CAMs role in, 130
 - Hebb's rule, 126
 - homeostatic synaptic plasticity, 128–129
 - long-term potentiation (LTP) and long-term depression (LTD), 126–127
 - presynaptic and postsynaptic, 128
 - morphologic changes in, 200

- Synaptic plasticity (*cont.*)
 neural activity, role in, 126
 NRXN/NLGN role in, 147
 physiological and molecular mechanisms, 129
 postsynaptic receptors, phosphorylation of, 127
- Synaptic scaffolding molecule (S-SCAM) and neuroligins binding, 357
- Synaptogenesis, 16–19, 21, 25–33, 41, 60, 68, 70, 72, 85, 115, 142, 174, 281, 355–356, 412, 414–416
 agrin and, 275, 398–399
 axons and dendrites, association between, 187, 199, 201
 and cadherins, 166–167
 CAM and, 236
 in CNS, 91–94
 FasII expression and FasII-mediated cell adhesion/signaling during, 285
 in HSN axons, 238–239
 L1-type cell adhesion molecules in, 253–256
MHC class I genes, 314–315
 muscle 12 expressing membrane-targeted GFP and RP5 motor axon, 30
 in PNS *in vivo*, 337–340
 SynCAM1 protein expression and, 201
 WNT7a and, 96–97
- Synaptopathies
 brain wiring alterations caused by CAM mutations in, 152
 cell adhesion molecules (CAMs) in, 141
 brain wiring alterations by mutations in, 152
 phylogeny of, 144
 structure, 143
- SynCAMs immunoglobulin-superfamily and synapse formation, 97–98, 154, 169, 189, 201, 237, 377
- Synchronization, 433
- Syndecan 2 CASK-interacting proteins, 89, 130
- T**
- Taiwanese banded krait venom
 α -bungarotoxin for study of vertebrate NMJ, 42
- Tello, J. F., 59
- Tetrodotoxin (TTX), 123, 129
 and neuromuscular synapse elimination, 111
- Thalamo-amygdala synapses of principal neurons, NMDA/AMPA ratio, 358
- Theiler's mouse encephalitis virus (TMEV) functional immune response and, 312
- Thrombospondins, 96
 at NMJ, 414–415
 role in synapse formation, 99
- Thymus-derived cytotoxic T-lymphocyte (CTL) surveillance, 302
See also Major histocompatibility complex class I (MHC class I)
- Toll, LRR family of transmembrane proteins, 19, 23, 30
See also Cell adhesion molecules (CAMs)
- Torpedo electric organ and NMJ isolation, 42–43
See also Vertebrate neuromuscular junction (NMJ)
- Triggering receptor expressed on myeloid cells (TREM2), 311–312
- Tubocurarine and neuromuscular synapse elimination, 111
- Tumour necrosis factor alpha converting enzyme (TACE) and cleavage of NCAM1, 279
- Type II inhibitory synapses, 87
- U**
- Usher syndrome (USH), 150, 154, 178
See also Cadherins and protocadherins (CDH/PCDH)
- V**
- van Gehuchten, A., 2, 3
- VASE-containing NCAM1 proteins, 270
- Veli/Lin-7 cytoplasmic proteins CASK-interacting proteins, 89
- Verrall, W. A., 3
 synapse term, 3
- Vertebrate nervous system, 12
- Vertebrate neuromuscular junction (NMJ)
 chemical neurotransmission, 40
 development of
 AChRs clustering in absence nerves and nerve-derived cues, 53
 aneural AChRs and motor axons, 54–57
 muscle-specific kinase (MuSK), 53
 postnatal pruning of supernumerary nerve terminals, 57
 synaptic differentiation, 52

- synaptic maturation and maintenance, 57–59
 - fluorescently labeled conjugated bungarotoxin (BTX), 42
 - molecular signals and synapse formation, 41
 - morphology of, 42–43
 - motor neurons and presynaptic terminals, 44–47
 - non-myelinating perisynaptic Schwann cells, 48–49
 - postsynaptic apparatus, 47–48
 - synaptic cleft and basal lamina, 49–52
 - motor axons and nerve terminals, 42
 - quantal and vesicular theories of neurotransmission, 41
 - study of, 39
 - synapses, molecular components of, 40
 - synaptic partners and, 40
 - and trans-synaptic cues, 59
 - agrin, 60–61
 - collagen IV, 63–65
 - growth factors, 68–69
 - laminins, 61–63
 - matrix-degrading enzymes, 67
 - matrix molecules, 66–67
 - nidogens, 66
 - synaptogenic molecules within synaptic BL, 60
 - transmembrane adhesion molecules, 70–71
 - Vesicles at excitatory presynaptic terminal
 - vesicular GABA transporter (VGAT), 87
 - vesicular glutamate transporter (VGLUT), 87
 - Visual system, axon pruning in, 121
 - astrocytes and C1q, role in, 123
 - CadN mutations and, 167
 - dorsal lateral geniculate nucleus (dLGN), 123
 - ECM role, 125
 - EphA receptor tyrosine kinases and ligands, 123–124
 - lateral geniculate nucleus (LGN), 122
 - in mammalian visual system, 122
 - MHC class I proteins, 123
 - neurotrophins role in ocular dominance column formation and plasticity, 124–125
 - retinal ganglion cells (RGCs) activities, 123
 - tissue-type plasminogen activator (tPA), 125
 - visual-driven activity and cortical connections, 124
 - Voltage-gated Ca^{2+} channels CASK-interacting proteins, 89
 - Vomerolateral sensory neurons (VSNs), 313
 - von Euler, U. S., 4, 6
 - noradrenalin as neurotransmitter of sympathetic nervous system, demonstration, 6
 - von Gerlach, J., 1
 - cellular organization of nervous system theory, 1
 - Reticular Theory, 1
 - von Kölliker, R. A., 2, 3
 - axon term for fiber-like extension, 3
 - von Waldeyer-Hartz, H. W. G., 2, 3
 - neuron term introduction, 3
- W**
- Walker–Warburg syndromes, 352, 409
 - WNT proteins function in synapse formation, 96–97
 - Wnt7a, 97
- X**
- X-Linked ichthyosis (XLI), 143–144
- Z**
- Zebrafish, zNCAM/NCAM1-3 expression, 52, 54, 169, 240, 266–267, 270–271, 275, 280–281, 328, 402