

Index

- acetylcholine, 6, 7, 19, 20, 21, 24, 44, 55, 86
- action potential, 15, 17, 20, 23, 29, 38, 40, 41, 43, 49–51, 89, 96–7, 113, 140, 191–3.
 Hodgkin-Huxley theory of, 101–103
 synchronized, 29, 194–203
- afterdepolarization, *see* depolarizing afterpotential
- afterdischarge, 31–2, 98, 124, 140, 152–6, 189–91, 197
- afterhyperpolarization (AHP), 20, 37, 39, 43, 51, 89, 96, 152, 164, 172, 183–5, 223
- amnesia, 9–12, 31–2
- amygdala, 7, 10, 31, 227
- anoxia, 30
- attractor, 176, 179–80, 208, 218
- aura, seizure, 31
- axon, 4, 5, 19, 57–60, 65
 conduction block, 155–6
 conduction velocity, 106, 134
 initial segment, 86, 99
 model, 74, 104
 output transduction, 106
 spatial distribution of connections, 61–4, 108–109, 133–4
 sprouting, 30
 squid, 88, 101–103
- backpropagation algorithm, 209
- basket cell, 4, 43, 51, 55
- behavioral state, 15
 consummatory, 27
 and EEG, 16–17
 walking, 16
- bicuculline, 26, 125, 183, 187, 229
- brainstem, influence on EEG, 21–2
- burst
 EPSP initiated by, 66
 field potential associated with, 124, 130, 134, 142, 152, 189, 191
 intrinsic, 37–43, 89, 96–7
 partially synchronized, 70–3, 140–51, 164
- synchronized, 69–71, 119–56, 182–7
 transmission, cell-to-cell, 67, 121–4
- cable equation, 77–8, 91–3
- calcium
 conductance, 20, 37–8, 89–90, 96, 154
 -independent K conductance, 20, 39, 89–90, 96
 -free media, 197
 intracellular, 35, 92
- carbachol, 19
- central pattern generator, xiv, xv, 6, 15, 25
- chandelier cell, 4, 43, 60
- channel, *see* conductance
- chaos, 175–80, 204
- cingulate gyrus, 6–7, 10, 12, 21
 sharp waves in, 28
 theta rhythm in, 21, 24
- CNQX (6-cyano-7-nitroquinoxaline-2,3-dione), 56, 172, 183, 187
- computational model, xiii, 33, 205
- conductance
 calcium, *see* calcium conductance
 leak, 75; *see also* membrane resistivity
 potassium, 20, 39–41, 88–90, 101–103
 rate functions, 93–4
 sodium, 88–90, 101–103
 synaptic, 46–57, 85–7; equations, 94–5;
 excitatory (glutamate), 86–7;
 GABA_A, 41, 50–1, 55, 57, 77, 86–7, 141; GABA_B, 41, 43–5, 87; kainate/
 quisqualate, 44, 56–7; NMDA, 13, 29–30, 44, 56, 77, 125, 152, 226, 229
- cornu Ammonis, 1
- déjà vu, 31
- dendrite, 90–1
 active properties of, 38–9, 41, 88–9, 154–5
 branching rule, 75–6
 current flow in, 74–85
 excitation on, 69, 85–7, 106–108, 202
 extracellular resistance near, 198–200
 inhibition on, 45, 86–7, 106–107

278 *Index*

- dentate granule cell, xviii, 4–5, 32, 38, 47, 49, 55, 57, 59, 63, 149, 181, 194
 electrotonic junctions, 51
 firing during sharp wave, 28
 firing during theta rhythm, 17, 22
 dentate gyrus, 1, 4, 6, 12, 17, 28, 159, 189
 aberrant excitatory connections in, 30
 inhibitory cells, 20
 depolarizing afterpotential (DAP), 38, 41, 89–90, 97
- EEG (electroencephalogram), 157–8, 198
 behavioral correlates, 15
 correlation dimension, 178
 ictal, 29, 31, 156
 interictal, 25–6, 29, 31, 69, 142, 150–1, 156, 202
 spindle, 20–1, 157
 what it measures, 82, 191–3
see also oscillation; synaptic potential, synchronized; theta rhythm
- electrotonic coordinates, 77, 84, 199, 228
 electrotonic coupling, *see* electrotonic junctions
 electrotonic junctions, 51, 57, 110–11, 127
 electrotonic length, 76, 83, 84–5, 87, 90, 113, 199, 228
 entorhinal cortex (EC), 5–7, 10–12, 16–20, 23–4, 28, 32, 193
 epilepsy 1, 10, 13, 24, 25, 29–33, 47, 123, 141, 147, 150–1, 156, 159, 189, 202, 229; *see also* afterdischarge; burst, synchronized; EEG, ictal; EEG, interictal; field burst; seizures; sharp wave
- epileptiform field potential, 130, 195, 202;
see also burst, synchronized
- EPSP (excitatory postsynaptic potential), 41, 56–7, 62, 65–7, 86, 119, 121–2, 130–1, 164, 170–2, 183–4
 during theta, 23
 epileptiform (“giant”), 26, 70–1, 131
 miniature, 56
 monosynaptic, 49–50, 51, 57, 65, 189
 onto inhibitory cell, 50, 66, 87, 189
 onto pyramidal cell, 49, 66–7, 189
 polysynaptic, 60, 65–73, 142; inhibitory control of, 67–9, 142
 spatial distribution, 62–4, 108–109, 133–8
 spontaneous, 140, 182, 183–7
see also conductance, synaptic, excitatory; quantal synaptic fluctuations; synaptic potential, synchronized
- eserine, 19
 excitatory cell, *see* pyramidal cell
 excitotoxicity, 30, 41, 226
 extracellular space
 approach to simulating, 198–200
 potential in, 14, 16–17, 28, 29, 75, 91, 127, 159, 194–203
 resistivity of, 194, 198–201
- failures, synaptic, 51–4, 57
 field burst, 29, 127, 196, 230
 field, extracellular
 effects, xvii, 127, 130, 156, 194–203
 rhythmic, 25, 159, 171–2
see also EEG; extracellular space, potential in; sharp wave; theta rhythm
- fimbria/fornix, 6, 18, 20
 lesion, 13
 transplant into, 18
- 4AP (4-aminopyridine), 34, 45, 57, 125, 141
- GABA, 4–5, 7–8, 19–20, 25, 36, 43–5, 54, 137, 156, 227
 actions, 43–45, 54–5, 86–7, 104, 106–110
 antibodies, 36
 blockade, 26, 29, 64, 66, 69–73, 123–6, 134, 142–9, 152–6, 158–9, 182–7
 -ergic connections, 5, 8, 19–20, 86, 104;
see also synaptic connections
 receptors: regulation, 44, 77; types, 44, 45, 86–7, 156
- gap junctions, *see* electrotonic junctions
 glutamate, 5, 23, 34, 47, 49, 64, 230
 blockade, 23, 153–154, 172
 receptors 44, 229
see also conductance; excitotoxicity; quisqualate
- heat equation, 78
 hilus, 5, 18, 227
 theta in, 17
- hippocampal sclerosis, 142, 227
 hippocampus
 anatomy, 1–9
 cell types, 4–5
 connections, 5–9
 deafferented, 30
 numbers of cells, 4
 synaptic organization, 3, 46–73
- HM (patient), 10
 Hodgkin-Huxley theory, 88, 89, 101–103
 hypothalamus, 6–7, 16–17, 226
- inhibitory cell (interneuron, *i* cell), 4–5, 36, 43, 45, 48, 55, 59–64, 65, 69, 104, 141, 149, 230
 excitation by acetylcholine, 8, 9, 25
 excitation by serotonin, 8
 firing during synchronized synaptic potential, 160, 165–72
 firing during theta, 22, 25, 182
 firing properties, 43, 65

- GABAergic connections to, 8, 20, 25
 membrane properties, 43, 87
 model of, 95, 97, 104–105, 106–107, 145
 recurrent excitation of, 49–50, 54, 59,
 65, 151, 172, 189, 224
 synaptic action on nearby cells, 50–1,
 54–7, 60, 65, 67–9
- inhibitory holes, 111, 145–6, 147, 169
 inhibitory surround, 137, 146, 150–2
 integration methods (for differential equations), 99–100
 interictal spike, *see* EEG
 interneuron, *see* inhibitory cell
- IPSP (inhibitory postsynaptic potential),
 51, 52, 60, 62, 69, 122, 140, 146, 152,
 164, 181
 blockade, *see* GABA blockade
 disynaptic, 65, 69, 87, 146, 169, 189
 during theta, 23
 fast (Cl^- , GABA_A), 41, 43–45, 86–87,
 104, 112–113, 165, 170–172, 183
 in inhibitory cells, 87, 109–10
 monosynaptic (unitary), 50–1, 60, 141
 in septal neurons, 20
 slow (K^+ , GABA_B), 41, 43–45, 86–87,
 104, 112–113, 131–132, 138, 148, 165,
 169–172, 177, 181, 183–4
 spontaneous, 60
- isolated neurons, 35, 38, 39, 44, 89
- kainic acid, 23, 125
 kindling, 123, 125, 189
 Klüver-Bucy syndrome, 10
 Korsakoff syndrome, *see* Wernicke-
 Korsakoff syndrome
- limbic encephalitis, 12
 limbic system, 7, 12, 17, 24, 161, 226
 locus ceruleus, 8
 long-term potentiation (LTP), 13, 32, 41,
 119, 224
 lumped circuit model, xvi, 90, 164, 225
- Mauthner cell, 46, 55, 57
 M-current, 8, 44, 88, 99
 membrane, 74
 active properties, 74, 77, 86, 88–99, 183,
 192; *see also* Hodgkin-Huxley theory
 capacitance, 75, 87, 90, 113, 227
 channels, 42, 44–5, 88, 194
 conductance, 15, 108
 current, xii, 37, 71, 85, 192, 194–5,
 198–9
 excitability, 29, 197
 oscillation, 40
 passive properties, 74–85, 90
 pump, 192
 resistivity, 75–6, 84, 87, 90, 113
- state variables, 92–6, 115–18, 180, 200
 time constant, 37, 43, 87, 90
see also space constant
- memory, xii, xiii, 9–12, 26, 32, 208, 223–4
 declarative, 9
 disorder, *see* amnesia
 in Hopfield model, 205–208, 210
 procedural, 9
 two-stage model, 32
- mesencephalic reticular formation, 8, 16
- model
 hippocampal network, results, 119–203
 hippocampal network, structure,
 104–118
 Hopfield, 205–208, 210
 simulation, xi–xviii
 single cell, 74–100
- Morris milky water test, 13
- mossy fibers, 2, 3, 5, 49, 56, 59, 63, 64, 67,
 86, 189, 225
- motoneuron, 21, 46, 55, 57, 59, 64, 88, 99,
 157, 227
- neocortex, 21, 25
 EEG, 193, 226
 epileptiform events, 26, 30, 139
 slices, xiii, 19, 30, 139, 159, 193
 synchronized synaptic potentials in, 159
- network, layered neural, 209–210; *see also*
 model
- NMDA (N-methyl-D-aspartate), *see* con-
 ductance, synaptic
- nucleus of the diagonal band, 6, 17, 18,
 19, 21
- nucleus, median raphe, 6, 7, 8, 22
- nucleus pontis oralis, 21
- optical recording, xv, 34–5, 99, 225
- orgasm, 9
- oscillation, 211
 of membrane potential, 23, 40, 120, 155,
 201
 in percolation model, 220–2
 in population of neurons, xvii, 6, 20,
 24–5, 120, 129, 155, 157–93, 201
- parahippocampal gyrus, 7, 10, 11, 12, 31
 paroxysmal depolarization shift (PDS), *see*
 burst, synchronized
- patch clamp, 35, 49, 88
- penicillin, 26, 29, 123, 125, 140, 154, 156,
 159, 172
 mechanism of action 229
- peptide neurotransmitters, 6, 8, 36, 41
- percolation, 146, 211–22, 223, 231
- perforant path, 3, 5, 7, 30, 32, 149
- physostigmine, *see* eserine

280 *Index*

- picrotoxin, 26, 29, 40, 45, 68, 69, 98, 124,
 125, 127–8, 131, 137, 142, 151, 152–6,
 182, 187, 189, 196, 197, 201, 223
 mechanism of action, 229
see also GABA blockade
 place cells, xiii, 1, 13, 31, 181
 polysynaptic EPSP, *see* EPSP, polysynaptic
 population burst, *see* burst, synchronized
 potassium
 extracellular, 15, 127, 140, 154, 156
 synchronization induced by, 29, 125,
 127, 140, 141, 146, 181, 182–7, 197–8
 see also conductance
 propagation
 along an axon, 101, 103
 along a cable, 83, 228
 burst, 66–7, 121–3, 129, 132, 145, 148,
 150, 164, 167, 170, 177, 184, 210
 epileptiform activity (synchronized
 burst), xvii, 133–8, 140, 154, 155, 197
 field burst, 197
 wave of synaptic potentials, 170
 pyramidal cell (e cell), xiv, xvi, xviii, 1–8,
 34–45, 140, 195, 214
 axon spread, 138, 230
 firing properties, 30, 37–43, 88–99, 138
 in high $[K^+]_o$, 140, 182–7, 197–8
 membrane properties, 37, 85, 90–1,
 197–8
 model of, 74–99
 in sharp wave, 28
 synaptic action on inhibitory cells, 48,
 50, 69, 145, 224
 synaptic action on pyramidal cells, 48–9,
 66, 121–4, 127, 140, 142–7, 224
 synaptic events in, 47–57, 86, 106–111,
 130, 131, 150–53, 157–82
 in theta rhythm, 17, 19, 21, 22–3
 in two-stage model, 32
 see also burst; place cells; synaptic
 connections
 quantal synaptic fluctuations, 51–7, 86,
 121, 130, 144, 180, 182
 quisqualate, 44, 56–7, 86, 172

 Rall theory of membrane properties, 74–85
 recurrent excitatory connections, xi, 5, 29,
 30, 48–9, 51–3, 57–60, 62, 64, 66–7,
 71, 86, 202
 behavior dependent upon, 119–91
 release site, synaptic, 46, 49, 51–7, 59–60
 REM sleep, 16, 21, 24, 157
 repetitive stimulation, 188–91
 resistance, input, 8, 21, 37, 43, 79, 91, 113
 resistivity
 extracellular, 194, 198–201
 internal, 75, 90, 113
 membrane, 75–7, 84, 90, 113, 208
 rhythmic slow activity, *see* theta

 Schaffer collaterals, xviii, 2–3, 5, 6, 28, 32,
 49–50, 63, 64, 106, 119, 225, 229
 seizures, 1, 14, 15, 18, 25–6, 29–33, 156,
 202–203
 absence, 178
 grand mal, 29
 partial complex, 9, 25–6, 30–2
 tonic, 156, 197, 202
 see also epilepsy
 septohippocampal relations, 7–8, 19–20
 septum (septal nuclei), 5–8, 9, 12, 13, 16–
 21, 24, 28, 161, 182, 193
 serotonin, 8, 22, 44
 sharp wave, 14–15, 20, 25–8, 31, 32, 119,
 141, 150
 simulation program, 115–18
 slice culture, 35, 49, 225, 230
 slice preparation, 1, 4, 15, 17, 33, 34, 48,
 62–4, 106, 193, 225; *see also* burst;
 EEG; propagation; pyramidal cell; sei-
 zures; synaptic connections; synaptic
 potential
 slow spike, 23, 38, 90, 96, 98, 152
 small sharp spike, 26–7, 28
 Sommer's sector, 227
 space clamp, 101
 space constant, 76, 192
 definition, 76
 frequency-dependent, 82, 192, 228
 spatial performance, 13–14
 spindle, EEG, *see* EEG spindle
 spreading depression, 9
 stratum
 lacunosum/moleculare, 3
 oriens, 3
 pyramidale, 2, 3
 radiatum, 3
 subiculum, 1, 6–7, 10, 21
 sharp waves in, 27, 32
 theta rhythm in, 17, 19, 24
 surround, inhibitory, *see* inhibitory
 surround
 synaptic actions, xii, 35, 85–7, 106–108
 excitatory, 4, 27, 29, 36, 41, 44
 inhibitory, 36, 43–5, 109–110
 see also conductance, synaptic; EPSP;
 GABA; IPSP; quisqualate
 synaptic circuits, 65–73, 120–3
 synaptic connections, xii, 5–7, 57–64, 108–
 109, 131
 convergence and divergence, 58–60
 density, 62
 recurrent, *see* recurrent excitatory
 connections

Index

281

- spatial distribution (model), 108–109, 134, 137–8
- spatial distribution (slice), 62–4, 133–7, 230
- synaptic current, 15, 17, 85
 - rectification, 86
 - time course, 85–7
- synaptic plasticity 32–33, 187–191; *see also* LTP
- synaptic potential, 46–73
 - amplitude, 47–51
 - synchronized, 23, 26, 157–82
 - unitary, xii, 47–51
- synaptic transmission
 - conductances, 47–51
 - failures, 52, 53, 57
 - latency, 47–51
 - miniature events, 54–7
 - quantal nature, 51–7
 - release probability, 53, 57
- synchronization, 14–16, 69–73, 119–56, 182–7, 223–4
 - curve, 14
 - by electric field effects, 194–203
 - mechanisms, 120, 127–8
 - single cell, induction by stimulation of, 64, 127, 130, 210
 - see also* burst; EEG; EPSP, epileptiform; oscillation; propagation; synaptic potential, synchronized
- tetanus toxin, 13, 125, 154
- thalamus, 7, 9, 12, 20, 21, 62, 119, 157, 193
- theta rhythm, 16–25, 34, 69, 119, 141, 160, 170, 193
 - behavioral correlates, 16
 - cellular physiology, 22–3
 - comparison with in vitro oscillations, 181–2
 - in primates, 24
- transient global amnesia, 9
- trisynaptic circuit, 5
- voltage clamp, 34–5, 42, 50, 86, 88, 89, 98, 101–103, 128, 155
- Wernicke-Korsakoff syndrome, 12