

Index

Page numbers in italics refer to content in figures; page numbers in bold refer to content in tables and boxes.

- acetylcholine (ACh), 151, 155, 212, 216, 466, 488, 562, 568
- action maps, 163, 166
- action potential, 56–59, 58, 70, 75
 - ganglion cells, 106
 - myelinated axons, 59–61
 - neurotransmitters, 62
- acuity, visual, 94
- adaptive immune system, 493–494
- addiction, 29, 255, 459–460
 - cocaine and amphetamine, 460–465, 461, 463
 - drug tolerance, 468–469
 - impulse control, 470–473, 472
 - withdrawal and craving, 469–470
- adenosine, 213
- adipose cells, 239, 243, 244
- adrenal cortex, 489, 498
- adrenal gland, 33, 282, 488, 494. *See also* hypothalamic–pituitary–adrenal (HPA) axis
- adrenal medulla, 488
- adrenaline, 488, 494
- adrenocorticotrophic hormone (ACTH), 488
- afferent information, 22
- afferent nerves, 14
- ageusia, 136
- aging, 320
- agnosia, 131
- akinesia, 551
- alcohol, 307–308, 316, 467–468
- alertness, 400–403, 401, 402
- alien hand syndrome, 171
- alpha melanocyte-stimulating hormones (α -MSH), 248
- alpha motor neurons, 148–151, 149, 151, 156, 160, 165
- alpha waves, 200, 201, 212
- alpha-fetoprotein, 285
- alpha-synuclein proteins, 553–555
- Altman, Joseph, 320
- Alzheimer, Alois, 560
- Alzheimer's disease, 355, 527–528, 560
 - bilinguals, 602
 - current research, 568
 - genetic and environmental influences, 565–567, 566
 - memory and cognitive deterioration, 560–561
 - neuronal loss and brain damage, 561–565, 562
- amacrine cells, 102
- amino acids, 62
- amnesia, 352–356, 355
- AMPA receptors, 333–335, 336, 372–377, 373, 386
- amphetamine, 79, 212, 221, 258, 403, 460–465
- amplitude (brain waves), 199, 200
- amputation, 323
- amygdala, 35, 285, 291, 295
 - anxiety, 509, 510, 511, 514, 517, 517
 - depression, 532
 - erasing fear memories, 386–388
 - fear conditioning, 384–386, 384, 385, 501–505, 503
 - stress, 490
- amyloid plaques, 560, 562–564, 563, 566, 568
- amyloid precursor protein (APP), 566, 566
- amyotrophic lateral sclerosis (ALS), 145–146
- androgen hormones, 275–277, 281, 284–285, 289, 291, 293, 297
- annual cycles, 193
- anorexia, 232, 260–263, 261

- anorexigenic chemicals, 249
 anosmia, 135
 antagonistic muscles, 153
 anterior brain, location, 17, 18
 anterior cingulate cortex, 415–417, 415, 537, 538, 601
 anterior pituitary, 297
 anterior prefrontal cortex, 606
 anterograde amnesia, 354–356, 355
 anteroventral periventricular nucleus (AVPV), 284
 antidepressant drugs, 8, 79, 264, 299, 532, 533–534, 534
 antihistamines, 220
 antipsychotic drugs, 546–549, 547
 anxiety, 66, 502
 abnormal activation of fear circuitry, 509–512, 511
 glucocorticoids, 515–518, 515, 516, 517
 treatments for, 512–515, 514
 anxiolytics, 219
 aphasia, 581, 590, 598–599. *See also* Broca's aphasia; Wernicke's aphasia
Aplysia (sea slugs), 390–392, 391
 apoptosis, 284, 316, 317
 arachnoid mater, 22
 arcuate nucleus, 246–248, 247
 aromatase enzyme, 276, 277, 281, 285
 arrhythmic sleep, 203
 astrocytes, 6, 8, 9
 atonia, 215, 223
 ATP molecules, 236, 239
 attention
 attention-deficit hyperactivity disorder (ADHD), 417–418
 frontal and parietal damage, 413–414
 frontal lobe and distractors, 414–417, 415, 416
 improvement via neuroscience training, 418–420, 419
 most relevant goal stimuli, 409–411, 412
 norepinephrine neurons and alertness, 400–403, 401, 402
 stimulus-driven vs. goal-directed, 403–409, 404, 404, 405, 406, 409
 attention-deficit hyperactivity disorder (ADHD), 417–418
 atypical antipsychotics, 549
 audition (hearing), 123–129, 124, 128, 327, 328
 auditory cortex, 126, 592, 593
 auditory nerves, 12, 13
 automatized behaviors, 179–180, 380–381
 autonomic nervous system, 14–16, 15, 17, 201, 249, 487
 autoreceptors, 63
 aversive stimuli, 502–503
 axon hillock, 56, 56, 70
 axons, 5, 6, 7, 9, 46–49, 48
 action potential, 56–58, 57
 growth of, 314, 315
 medulla, 28
 motor neurons, 150
 myelination, 59–61, 60
 olfaction (smell), 134
 plasticity, 326, 332
 recovery from damage, 337–338
 somatosensation, 131
 spinal cord, 23
 visual system, 102–104, 103
 A δ fibers, 130
 background stimuli, 403, 404
 Baddeley, Alan, 421–422, 422
 bariatric surgery, 259–260, 259
 basal ganglia, 29, 34, 35, 148, 176–180, 178, 381, 477, 557–558
 basal metabolism, 236, 257
 baseline states, 496
 basilar membrane, 124–126, 126
 bed nucleus of the stria terminalis, 291
 behavioral abilities development, 318–320
 behavioral control, 174–175, 175
 behavioral stereotypy, 178
 behavioral therapy, 341. *See also* cognitive behavioral therapy (CBT)
 benzodiazepines, 66, 219, 514
 beta amyloid, 562–564, 566, 566
 beta waves, 200, 201
 bicep muscle, 153, 154
 bilateral symmetry, 16, 31
 bilinguals, 601–602
 binge-eating disorder (BED), 265
 binocular cues, 120
 biological clocks. *See* circadian rhythms

- bipolar cells, 98, 99, 100, 106
- bipolar disorder, 529
- Bleuler, Eugen, 540
- blind spots, 91, 93
- blindness, 121
- blindsight, 121
- blood oxygenation level-dependent (BOLD) activation, **21**, 600, 604
- blood vessels, 78
- blood–brain barriers, 78
- body mass index (BMI), 253, 253, 261
- body weight, 250–251. *See also* obesity
- bonobo apes, 292
- bottom-up attention. *See* stimulus-driven attention
- bradykinesia, 551
- brain damage, 4, 171, 182, 191, 335–336
 - contralateral neglect, 413, 414–414
 - treatments for, 337, 340–343
- brain development, 307–308, 309, 310
 - behavioral abilities, 318–320, 319
 - five phases, 310–317
 - nervous systems of various species, 308–309
 - neurogenesis in adulthood, 320, 321
 - neurotrophic factors, 317–318, 318
- brainstem, 26–29, 26, 27, 104, 104, 148
 - hunger, 246
 - movement, 158, 160
 - sleep–waking, 208, 210, 213, 214–217, 215, 216, 217
 - stress, 488, 490
- brain tissue, 1, 2, 4
- brain trauma, 335
- brain waves, 197–201, 198
- brain–computer interface (BCI), 339–341, 340
- brain-derived neurotrophic factor (BDNF), 332
- Broca's aphasia, 590–592, 592
- Broca's area, 590–594, 591, 592, 593, 601
- bulimia, 263–265
- buprenorphine, 467
- C fibers, 131
- CA1 area, 361
- CA3 area, 361
- caffeine, 213, 219, 556
- calcium ions (Ca^{2+}), 62, 73, 75, 333, 336, 372, 373, 374, 376
- callosotomy, 582, 583
- calorie consumption, 254–255, 256–257
- camera–eye analogy, 89–90, 90
- carbohydrates, 235, 236
- Cartesian impasse, 2
- catalepsy, 177
- cataplexy, 220
- catecholamine, 462
- causal brain. *See* posterior brain
- cell adhesion molecules (CAMs), 314
- cell birth, 311
- cell body, 5, 6, 46–49, 48, 70
 - damage to axons, 337
 - neurotransmitters, 62
 - norepinephrine neurons, 401
- cell death, 316–317, 316
- cell proliferation, 308
- cell-autonomous signaling, 314
- center–surround receptive fields, 106–110, 107, 114
- central canal, 23, 25
- central executive, 422
- central hearing loss, 129
- central nervous system (CNS), 12–13, 12, 16–19
 - brain development, 309, 316
 - hunger, 246
 - injuries, 335–336
 - recovery from damage, 337–343, 340
- central nucleus of the amygdala (CeA), 384–385, 384, 503
- central pattern generators (CPGs), 158
- central sulcus, 38, 38, 162
- cerebellum, 26, 28, 180–183, 184, 381–382
 - eyeblick conditioning, 388, 389
 - movement, 146
- cerebral aqueduct, 23
- cerebral cortex, 16, 32, 37–40, 37, 39, 76
 - basal ganglia, 176, 177, 178
- brain development, 312
- depression, 532
- memory, 356–360, 358, 361, 362
- norepinephrine neurons, 401
- sensory systems, 86
- sex, 285
- sleep–waking, 210–212, 214, 214, 217
- cerebrospinal fluid, 23
- cervical division, 148–149

- channelrhodopsin, 450
- Chantix (varenicline), 466
- chemical nociceptors, 130
- chemoattractants, 312, 314
- chemorepellants, 312, 314
- chimeric mice, **8**, 9
- chimpanzees, 38
- chloride ions (Cl⁻), 51
- chlorpromazine, 547
- cholecystokinin (CCK), 242, 243
- choroid plexus, 23
- chromosomes, 280, 289, 290, 293
- cilia, 133, 134
- circadian rhythms, 192–197, 194
- classical conditioning, **351**, 351, 352, 443, 443
- climbing fibers, 183, 184
- cloacal exstrophy, 289
- CLOCK gene, 196
- cocaine, 212, 460–465, 461, 463, 472, 474, 476
- cochlea, 123, 124
- cochlear nucleus, 126
- cocktail party effect, 414
- cognitive behavioral therapy (CBT), 220, 263, 264, 513, 534–535, 549
- cognitive functions, 40, 567, 602
- cognitive reserve, 567, 602
- color, visual, 95–96, 95, 97, 119
- compatible conditions, 415, 415
- compensatory strategies, 341
- complex cells, 114
- complex cognition, 38
- concept neurons, 366–368
- conceptual representations, 588
- concordance rates, 531
- conditioned aversive stimulus, 444
- conditioned drug tolerance, 468
- conditioned reinforcers, 443
- conditioned response, 383
- conditioned reward stimulus, 444, 548
- conditioned stimulus (CS), 244, 384, 388, 443, 444, 453–455, 455
- fear, 383, 386, 502–503, 505–508
- conduction aphasia, 598
- conduction velocity, 59
- conductive hearing loss, 129
- cones (photoreceptors), 90, 92, 94–96, 95, 97, 99, 119
- congenital adrenal hyperplasia, 281
- congenital leptin deficiency, 243
- conjunction search, 404, 405
- consolidating memories, 354
- constraint-induced movement therapy, 341
- continuous positive airway pressure (CPAP), 222, 222
- contralateral movement, 160, 582, 583
- contralateral neglect, 400, 413–414, 414
- convergent connections, 76, 77, 91, 94
- cornea, 89
- coronal plane, 18, 19
- coronary heart disease, 253
- corpus callosum, 17, 285, 579, 582, 583, 587
- cortical layers, 38, 39
- corticobulbar neurons, 160
- corticogeniculate pathways, 113
- corticospinal neurons, 160, 161, 165, 166
- corticosterone, 489
- corticotropin-releasing hormone (CRH), 469, 488, 509
- cortisol, 489, 530
- cranial nerves, 16, 17, 148
- creative thinking, 41
- CT (computerized tomography) scans, **19**, 21
- cup-lifting example, 146–148, 147, 156, 181
- Cymbalta, 533
- cytokines, 493
- cytoplasm, 276, 278
- daily cycles, 192–193
- dark currents, 98
- Davis, John D., 251
- deep brain stimulation (DBS), 192, 210, 210, 537, 557–558, 558
- deep cerebellar nuclei, 183
- default network, 603–604, 604
- degradation, 65
- delay-period activity, 423, 423, 424, 427–429, 428, 429
- continuous neuronal activity, 429–430, 430
- delta waves, 201
- delusions, 540, 548
- Dement, William, 221
- dementia, 223

- dendrites, 5, 6, 9, 38, 46–49, 48, 70, 71
 - neuron activation, 53
 - visual cortex, 331, 331
- dendritic branching, 517, 517
- dendritic spines, 476, 477
- dentate gyrus, 320, 360, 361
- depolarization, 54–57, 58–59, 69, 71, 75
 - hair cells, 126
 - synaptic plasticity, 371, 372, 386
 - visual system, 98
- depression, 8, 219, 528–530, 532
 - brain structure and function, 36, 531–532, 532
 - stress and genes, 530–531
 - treatments for, 446, 533–538, 534, 537
- depth perception, 120–121
- Descartes, René, 2, 3, 33
- desynchronized neurons, 199, 212
- diencephalon, 30–33, 30
- dietary proteins, 62
- dieting, 256–257
- differentiation, 312–314
- diffusion, 51
- diffusion MRI, 546
- digestion, 235–239, 235
- distractor stimuli, 403, 404, 405, 405, 414–417, 418
- distributed network models, 362, 363
- Disulfiram (Antabuse), 468
- divergent connections, 76, 77
- DNA, 46, 277, 294, 386, 499, 500, 531
- dopamine, 29, 34, 62, 66, 76, 255, 258
 - anatomy of pathways, 446–448, 447
 - attention, 418
 - drug reward, 460–465, 461, 463, 464
 - drug tolerance, 470
 - electrical brain stimulation, 448–450, 449
 - financial, social, and sexual reward, 456–458, 456, 458
 - food reward, 452–456, 455
 - influence on behavior, 177–179
 - nicotine, 466
 - opioid drugs, 467
 - Parkinson's disease, 342, 556–557
 - psychoactive drugs, 79
 - reward learning and plasticity, 473–478, 475, 477, 477
 - schizophrenia, 547–549, 547
 - sex, 295, 299
 - dopamine antagonists, 448–449, 449, 452, 463–465, 548–549
 - dopamine D₂ receptors, 547, 548
 - dopamine hypothesis of schizophrenia, 547
 - dopamine transporters, 460
- dorsal brain, location, 18, 19
- dorsal horns, 151
- dorsal premotor cortex, 167, 168, 171
- dorsal raphe, 490
- dorsal root ganglia, 131
- dorsal stream, 116–117, 116, 119
 - audition (hearing), 128
 - goal-directed attention, 410, 411
- dorsolateral prefrontal cortex (dorsolateral PFC), 415–417, 415, 416, 424–426, 424, 428, 473
- dreams, 207–209
- drug reward, 459–460
 - alcohol, 467–468
 - cocaine and amphetamine, 460–465, 461, 463
 - heroin, morphine, and oxycodone, 467
 - impulse control, 470–473, 472
 - learning and plasticity, 473–478, 475, 477
 - nicotine, 465–466
 - tolerance, 468–469
 - withdrawal and craving, 469–470
- drugs. *See also* drug reward
 - antipsychotics, 546–549
 - dopamine antagonists, 448–449, 449
 - neurotransmission, 78–80
 - obesity treatment, 257–259, 265
 - reinforcement, 443
 - sexual effects, 299
 - sleep medications, 219–220
 - stimulants, 212, 219, 221, 403, 418
- dualism, mind–body, 2–4
- dura mater, 22
- dyslexia, 600–601, 600
- eardrum (tympanic membrane), 123, 124
- eating disorders, 260–265, 261
- eating habits, 244–245
- ectoderm, 308
- efferent information, 22
- efferent nerves, 14
- Effexor, 514, 533

- electrical signals, 46–49, 48
- electrical stimulation, 349–350, 369, 372, 439–440, 445–446, 447
 - dopamine's role, 448–450, 449
- electroconvulsive therapy (ECT), 536–537, 537
- electroencephalograms (EEGs), 197–201, 198, 209, 212, 339
- electromagnetic spectrums, 88, 89
- electromyograms (EMGs), 198, 199–201
- electrooculograms (EOGs), 198, 199–201
- electrostatic pressure, 53, 53
- embryo, 308, 309
- emotional regulation, 36
- endocrine glands, 274–276, 275
- endoderm, 308
- endogenous biological clocks, 195
- endogenous opioids, 467
- endothelial cells, 78
- energy expenditure, 257
- energy supply, 234, 235–239, 238, 239, 240, 242
- enkephalins, 467
- enriched environments, 378
- entorhinal cortex, 361, 361
- entrained behavior, 194
- environmental stimuli, 76
- epigenetics, 499, 531, 544
- epilepsy, 66, 323, 325, 349, 352, 579
- episodic memory, 350, **351**
 - amnesia, 352–356, 355
 - concept neurons, 367
 - hippocampus–cortex interaction, 356–360, 358
- esophagus, 236
- estradiol, 276, 277, 281, 285, 297
- estrogen hormones, 276–277, 284–285, 297–298
- ethyl alcohol, 336
- excitation, 49, 65–67, 73, 75
 - memory, 357
 - photoreceptors, 98
 - working memory, 429, 430
- excitatory postsynaptic potential (EPSP), 67, 69–71, 75
- excitotoxicity, 336
- exercise, 257, 536
- exocytosis, 62, 63
- explicit memory, 350, **351**
- extension movement, 153, 156
- extinction learning, 442, 442, 505–508, 507, 512
- extracellular fluid, 51, 52
- eye movements, 199
- eye structure, 88, 90. *See also* vision
- eyeblink conditioning, 388–390, 389
- family-based therapy, 263
- fast-spiking, 61
- fat, 235, 237–239, 239, 240, 243, 257
- fatty acids, 239, 239
- fear
 - amygdala's role, 501–505, 503, 504
 - extinction learning, 505–506
 - medial prefrontal cortex (mPFC), 506–508, 507
- fear conditioning, 383–386, 384, 385, 505–508, 507
- fear memories, erasing, 386–388
- fenfluramine, 258
- Fetal Alcohol Syndrome (FAS), 307
- fight or flight responses, 14, 35, 487–488, 487
- financial reward, 456–457, 456
- firing neurons, 55, 57, 60, 63, 70, 75
 - abnormal levels, 66
 - norepinephrine, 401–402
 - place cells, 365
 - reticular nucleus, 213
 - sleep–waking, 199
 - synaptic plasticity, 370
 - visual systems, 106–110, 113
 - working memory, 423, 424, 425
- firing threshold, 55, 70, 75
- flexion, 153, 156
- fMRI (functional MRI), **21**, 163, 164, 173, 174, 409, 419–420, 419, 486, 545, 604
- follicle stimulating hormones, 297
- food cravings, 244
- food reward, 452–456, 455
- forebrain, 27, 29, 37, 76
 - epilepsy, 325
 - sleep–waking, 214–215, 215
 - stress, 490
- forward models, 382
- fovea, 91, 94
- free running behavior, 194, 196
- frequency (brain waves), 199, 200

622 INDEX

- frontal cortex, 29, 159. *See also* prefrontal cortex; primary motor cortex
- basal ganglia, 176, 177
- movement, 146, 158, 181, 183
- plasticity, 331
- working memory, 431
- frontal eye fields, 175–176, 406, 409
- frontal lobe, 40, 76, 167, 592, 593
 - attention, 414–417, 415, 416
 - damage to, 413–414
 - drug reward, 471
- frontal plane. *See* coronal plane
- fruit flies, 206, **206**, 296
- functional tolerance, 468
- fusiform face area (FFA), 120, 120
- fusiform gyrus, 430, 431
- GABA (gamma-aminobutyric acid), 66, 213, 514
- gambling disorder, 457
- ganglion cells, 100, 100, 102–105, 106–111, 107, 110, 488
- gap junctions, 73, 75
- gastric bypass, 259, 259
- Gazzaniga, Michael, 584
- gender dysphoria, 290
- gender identity, 274, 288–290. *See also* transgender individuals
- gene expression, 73, 277
- generalized anxiety disorder, 510
- genes
 - Alzheimer’s disease, 565–567, 566
 - depression, 530–531
 - dyslexia, 600
 - obesity, 255
 - Parkinson’s disease, 555
 - schizophrenia, 543–544, 543
 - stress, 499
- genitalia. *See* sexual organs
- gestation, 280, 281
- ghrelin, 242, 246
- glia, 6–7, **8**, 9, 59, 312, 320, 321, 331, 338
- glial progenitor cells (GPCs), **8**
- global aphasia, 598
- globus pallidus, 34, 177, 178, 557
- glomeruli, 134
- glucagon, 237
- glucocorticoids, 488, 489, 489, 497–501, 498, 500, 515–518, 515, 516, 517
- glucose, **20**, 78, 236–237, 238, 239, 240, 241, 246, 488
- glucostatic theory, 240
- glutamate, 66, 73, 333–335, 336, 369–375, 386
 - habituation, 391
 - reward, 474, 477
- glycerol, 239, 239
- glycogen, 237, 238, 239
- glymphatic system, 224
- goal-directed attention, 404–411, 404, 405, 406, 409
 - most relevant stimuli, 409–411, 412
- Golgi tendon organs, 155, 155
- gonadal hormones, 275, 297, 298. *See also* estradiol; testosterone
- gonadotropin-releasing hormones, 297
- gonads, 275, 276, 280
- G-proteins, 73
- graded potentials, 69–71, 71
- granule cells, 183, 184
- gray matter, 8, 10, 22, 37, 150, 151, 531, 532
- growth cones, 314, 315, 338
- guanfacine, 432
- gustation (taste), 132, 136, 137
- gyri, 37, 37, 309, 595–597, 595
- habituation, 390–392, 391
- hair cells, 124–126
- Haldol, 79
- hallucinations, 221, 541, 548
- hearing, 123, 124, 128–129, 327, 328
- heart, 40
- Heath, Robert, 440
- heat-sensitive neurons, 55, 62
- hedonic properties, 440, 453
- hemispherectomy, 325, 325
- hemispheres, 37, 579–580, 581, 583
 - left and right specializations, 580–582
 - split-brain surgery, 582–587, 583, 585
 - visual system, 585–587, 586, 587
- hemorrhage, 335
- heroin, 79, 443, 444, 467, 468
- higher-order visual areas, 116–117, 116, 410, 412
- hippocampal memory indexing theory, 357

- hippocampus, 35, 80
 - anxiety, 517–518, 517
 - brain development, 320, 321
 - default network, 604
 - depression, 530
 - information's route to, 360–361, 361, 362
 - learning, 377
 - memory of people and things, 366–368, 367
 - memory of places, 363–366
 - memory overview, 349–350, 349, 352–354, 353
 - memory recall, 356–360, 358
 - plasticity, 322, 326, 331
 - stress, 498, 498, 499
- histamine, 212
- Hitch, Graham, 421–422, 422
- homeostasis, 196, 232–235, 240–241, 496
- homosexuality, 292–294
- horizontal cells, 100
- horizontal lines, 117
- horizontal plane, 18, 19
- hormones
 - pituitary, 32
 - sexual development and behavior, 274–277, **276**, 277, 278, 293, 297–300
- hot cup example, 47, 49, 53, 55–56, 62, 74–75
- Hubel, David, 113–114
- hunger
 - body weight influences, 250–251
 - eating disorders, 231–232, 260–265, 261
 - homeostasis, 232–235, 240–241
 - hypothalamus' role, 245–250, 247
 - nutrients and energy, 235–239, 238, 239
 - obesity and its causes, 251–256, 252, 253
 - obesity treatments, 256–260, 259
 - physiological, emotional, and cognitive signals, 241–245, 242
- hyperpolarization, 98, 99
- hypnagogic hallucinations, 221
- hypnotics, 219
- hypothalamic–pituitary–adrenal (HPA) axis, 488, 489, 490, 492, 494, 495, 498, 501, 509
- hypothalamus, 32, 33, 212–214, 217, 221, 247. *See also* hypothalamic–pituitary–adrenal (HPA) axis
 - hormones, 275
 - hunger, 242, 244, 245–250
 - plasticity, 326, 332
 - sex, 283, 291, 295–296, 297, 298, 298
 - sleep–waking, 210
- imaging techniques, **19–22**, 21, 418, 431, 431, 454. *See also* fMRI (functional MRI); MRI (magnetic resonance imaging)
- immune system, 493–496, 495
- implicit memory, **351**, 351, 352. *See also* skill learning
- impotence, 300
- impulse control, 470–473
- incompatible conditions, 415–417, 415
- inductive signals, 314
- industrial revolution, 254
- inferior brain. *See* ventral brain
- inferior colliculus, 29, 126, 128
- inferior parietal lobe, 168–171, 169
- information processing, 5
- inhibition, 49, 65–66, 67–69, 75
 - lateral neurons, 100
 - obesity, 255
 - photoreceptors, 98
- inhibitory control, 470–473
- inhibitory postsynaptic potential (IPSP), 69–71, 75
- innate immune system, 493–496, 495
- insomnia, 218–220
- instrumental learning, 443
- insular cortex, 503, 503, 510, 511
- insulin, 237, 238
- integrated movement, 165–166
- interaural intensity difference, 128
- interaural timing difference, 126
- intersex, 281
- intracellular fluid, 51, 52
- intracellular proteins, 312
- intralaminar nucleus, 210, 212
- intraparietal sulcus, 406, 409, 431
- ionotropic receptors, 72, 74
- ipsilateral movement, 160
- ischemia, 335

624 INDEX

- Jenner, Caitlyn, 290
- jet lag, 197
- Johns Hopkins Medical School, 325
- Jouvet, Michel, 214–215, 215
- K⁺. *See* potassium ions (K⁺)
- Kandel, Eric, 390–392
- ketamine, 534
- ketones, 239
- koniocellular layers, 111
- Korsakoff syndrome, 355
- language, 588–590, 589, 590
 - aphasia variations, 598–599
 - bilinguals, 601–602
 - Broca's area, 590–594, 591, 592, 593
 - dyslexia, 600–601, 600
 - speech comprehension, 594–598, 595, 596, 597
 - Wernicke's aphasia, 594
- large intestine, 236
- lateral amygdala, 384, 385, 386, 387, 503
- lateral brain, location, 19
- lateral geniculate nucleus (LGN), 105, 111, 112, 326
 - primary visual cortex, 113, 114, 114
- lateral hypothalamus (LH), 246–249, 247, 384, 384
- lateral inhibition, 100, 101
- lateral striatum, 180
- lateral sulcus, 38, 38
- L-DOPA, 79, 179, 556–557
- learning. *See also* memory
 - Aplysia* case study, 390–392, 391
 - neurogenesis, 377–378
 - reward-related, 440–444, 441, 442, 443
 - skill learning, 378–382
 - synaptic plasticity, 369–377, 370, 371, 373, 374
- left hemisphere, 16, 37, 580–582, 583
 - Broca's aphasia, 592
 - dyslexia, 600
 - split-brain surgery, 582, 583, 585–587
 - visual system, 102, 585, 586, 587–587
 - Wernicke's aphasia, 598
- left inferior frontal gyrus. *See* Broca's area
- lens, 89, 91
- Lepsiens, Jöran, 431
- leptin, 242, 243–244, 244, 249, 259
- Levi-Montalcini, Rita, 317–318
- Lewy, Frederic, 553
- Lewy bodies, 223, 553–554, 554
- Libet, Benjamin, 169, 170
- Librium, 219
- lidocaine, 80
- light, 88, 89
 - photoreceptors' response to, 98–105, 99, 99, 100, 103
 - reaching the retina, 88–96
 - visual system's response to stimuli, 106–114, 107
- light-sensitive channels, 450, 451
- limbic system, 35, 36
- lipostatic theory, 240
- lisdexamfetamine dimesylate (LDX), 265
- liver, 237, 239
- lobes, overview, 37, 38, 39–40
- local anesthetics, 80
- local spinal cord neurons, 47, 156
- localist network models, 363, 363
- locus coeruleus, 384, 384, 401, 490
- Loftus, Elizabeth, 359
- longitudinal fissure, 37, 38
- long-term depression (LTD), 335, 375
- long-term potentiation (LTP), 333–335, 334, 371, 372–375
- looped circuits, 177
- lordosis, 287
- lower motor neurons, 160
- lower-order visual areas, 411, 412
- lumbar division, 149
- luteinizing hormones, 297
- macrophages, 493
- magnesium ions (Mg⁺⁺), 372, 373, 376
- magnocellular layers, 111
- major depressive disorder. *See* depression
- masculinization, 280–282, 285, 287
- material–immaterial dualism, 2–4
- MDMA (ecstasy), 79
- mechanoreceptors, 129, 130, 131
- medial brain, location, 19
- medial forebrain bundle (MFB), 446, 447, 448
- medial geniculate nucleus (MGN), 126, 326–329

- medial parietal lobes, 604
- medial prefrontal cortex (mPFC),
 506–508, 507, 604, 604, 607, 607
- medial preoptic area (mPOA), 283, 297,
 299
- medial striatum, 180
- medial temporal lobe, 349, 350, 352–354,
 353, 356, 366, 367. *See also*
 amygdala; hippocampus
- meditation, 200, 535–536, 603
- medulla, 26, 28, 136, 216, 246, 490, 491
- Meissner's corpuscles, 129
- melatonin, 33, 220
- membrane potential, 54, 54–55, 56,
 57–58
- neurotransmitters, 69–71, 71
- memory, 35, 349–351, **351**, 352. *See also*
 learning; working memory
 Alzheimer's disease, 560–561
 amnesia, 352–356, 355
 default network, 603
 erasing fear memories, 386–388
 eyeblick conditioning, 388–390, 389
 familiar people and things, 366–368,
 367
 familiar places, 363–366
 fear conditioning, 383–386
 hippocampus–cortex interaction,
 356–360, 358
 information's route to the
 hippocampus, 360–361, 361
 myelination, 60
 patterns of memory neurons, 362–363,
 363
- meninges, 22
- mental lexicon, 589
- mentalizing, 606–608, 607
- Merkel's disks, 129
- mesencephalon. *See* midbrain
- mesocortical dopamine pathway, 448
- mesoderm, 308
- mesolimbic dopamine, 448, 453
- metabolic tolerance, 468
- metabolism, 243, 257, 468
- metabotropic receptors, 73, 74
- metacognition, 605–606
- methadone, 467
- methyl groups, 499
- methylphenidate (Ritalin), 221, 418
- microglia, 7
- microtubules, 564, 565
- midbrain, 26, 29, 35, 76
 dopamine, 446
 substantia nigra, 177
- migration, neuronal, 311–312
- Miller, George, 421
- Milner, Brenda, 354
- Milner, Peter, 445–446
- mind–body dualism, 2–4
- mindfulness meditation, 535–536
- mirror neurons, 172–173, 173
- mitochondrial dysfunction, 554
- mitral cells, 134
- Mock, Janet, 273, 290
- modafinil (Provigil), 221
- Molaison, Henry, 352–354, 353,
 357, 360
- Money, John, 289
- monism, 4
- monoamine oxidase inhibitors (MAOIs),
 533
- monoamines, 27
- monocular cues, 120
- monolinguals, 601
- mood disorders, 7
- morphine, 467
- morphology, 312
- mossy fibers, 183, 184
- motor commands, 28, 32, 146, 150, 156,
 160, 181
- motor cortex, 592–593, 593
- motor disorders, 158
- motor learning, 28, 156
- motor neuron disease, 145–146
- motor neurons, 47, 75, 148–151, 149,
 151, 152, 160, 161, 165, 216, 391
- mouth, 235
- movement, 29, 32, 39, 145–148, 147
 basal ganglia, 176–180
 cerebellum, 180–183
 consequences, 181–182
 goals, 173–174, 175–176
 muscle activation, 148–158, 149, 150,
 151, 152, 157
 prefrontal cortex (PFC), 173–176
 premotor areas, 167, **169–170**
 primary motor cortex, 158–166
- MPTP, 556
- MRI (magnetic resonance imaging), 19,
 21, 21, 322, 581, 583

- MSG (monosodium glutamate), 136
 MT (dorsal stream area), 119, 121
 Müllerian ducts, 280, 282
 Müllerian-Inhibiting Factor, 281
 multiple trace theory, 360
 muscle
 activation, 148–158, 149, 150, 151, 152, 157, 199
 atonia, 201
 fibers, 150–153, 152, 153, 165
 relaxants, 219
 spindles, 155, 155
 myelin, 7, 11, 23, 59–61, 60, 338, 471
 Na⁺. *See* sodium ions (Na⁺)
 naltrexone, 468
 narcolepsy, 220–222
 National Institute on Drug Abuse (NIDA), 465
 National Institutes of Health (NIH), 192
 negative feedback, 63, 489
 negative reinforcement, 443
 negatively charged proteins (Prot⁻), 51
 neologisms, 594
 nerve endings, 131
 nerve growth factor (NGF), 318, 318
 nervous system. *See* brain development;
 central nervous system (CNS);
 peripheral nervous system (PNS);
 plasticity
 networks, brain regions, 406–409, 406
 neural progenitor cells, 311
 neural tube, 309, 311, 311, 312
 neurofibrillary tangles, 560, 563, 564–565, 565, 568
 neurogenesis, 9, 320, 321, 377–378, 518
 neuroleptics. *See* antipsychotic drugs
 neuromodulators, 66
 neuromuscular junction, 151, 153, 155
 neuronal assemblies, 379–380, 380
 neurons, overview, 5, 6
 neuropeptide Y (NPY), 247
 neurotransmitters, 5, 46–49
 excitation and inhibition, 65–69, 99
 forms of neurotransmission, 72–73, 74
 graded potential, 69–71
 muscle activation, 151, 154
 psychoactive drugs, 78–80
 release into synapse, 62–64, 63, 64, 65, 78
 reuptake, 64, 460, 533
 sleep–waking, 211
 spacial and temporal summation, 69
 neurotrophic factors, 317–318, 318, 332
 neutral stimulus, 383, 502
 nicotine, 212, 465–466, 556
 nicotinic receptors, 151
 nigrostriatal dopamine, 34, 177, 179, 448, 453, 552, 552
 nitric oxide, 300
 NMDA receptors, 333, 336, 372–377, 373, 386, 534
 Nobre, Anna C., 431
 nociceptors, 130–131
 nodes of Ranvier, 59
 non-rapid eye movement (non-REM), 192, 200, 201, 204, 212–214, 224
 non-restrained eaters, 245
 norepinephrine, 27, 66, 211, 212, 221, 258, 449
 alertness, 400–403, 401, 402
 depression, 533, 534
 drug reward, 460, 461
 psychoactive drugs, 79
 stress, 488
 Novocain, 53
 nucleus accumbens, 295, 299, 440, 448, 449, 450, 453, 456–458, 456, 465, 466, 470
 nutrients, 235–239, 238, 239, 243
ob gene, 244
 obesity, 243, 244, 251–253, 252, 253
 causes of, 254–256
 treatments for, 256–260, 259
 occipital lobe, 39, 40, 580
 occipitotemporal junction, 600
 ocular dominance columns, 117, 118
 odorants, 132–136
 Olds, James, 445–446
 olfaction (smell), 12, 132–136, 135
 olfactory bulb, 320, 343, 377
 olfactory ensheathing cells, 342–343
 oligodendrocytes, 7, 11, 338
 operant learning, 443
 opiate neurotransmitters, 79
 opioid drugs, 219, 467. *See also* heroin

- optic chiasm, 102
- optic disk, 91
- optic nerve, 102, 105
- optic tract, 102, 105
- optogenetics, **22**, 450, 451
- orbitofrontal cortex, 134, 457
- orexigenic chemicals, 249
- orexin, 212, 221, 249
- orientation columns, 117, 118
- ossicles, 123, 124
- ovaries, 275, 280, 281, 297
- overeating (hyperphagia), 246
- ovum, 279, 279
- oxycodone, 467
- oxygen, 78
- oxytocin, 298–299, 300

- Pacinian corpuscles, 129
- pain, 130–131
- pancreas, 237
- panic disorder, 510
- paradoxical kinesia, 553
- parahippocampal gyrus, 430, 431
- paraplegia, 149
- paraquat, 555
- parasympathetic nervous system, 14–16, 15, 249, 487, 487
- paraventricular nucleus (PVN), 246, 247, 249, 488, 491, 492
- parietal cortex, 406, 431
- parietal lobe, 39, 76, 131
 - damage to, 413–414
 - movement, 146, 164–165
- Parkinson’s disease, 34, 177, 223, 342, 550
 - genetic and environmental influences, 555–556
 - L-DOPA, 79, 556–557
 - Lewy bodies, 553–555, 554
 - modern technological treatments, 557–559
 - motor symptoms, 448, 550–553, 551
- parvocellular layers, 111
- Passions of the Soul*, 2
- pathogens, 493
- Pavlovian conditioning. *See* classical conditioning
- Penfield, Wilder, 350
- Penfield body map, 163

- periaqueductal gray (PG), 384, 384
- peripheral nervous system (PNS), 12–16, 12, 337–339, 338
- pesticides, 556
- PET (positron-emission tomography) scans, **20**
- phantom limb pain, 323, 324
- pheromones, 296
- phonemes, 588, 589, 590, 590, 596
- phonological forms, 588
- phonological loop, 422
- phonological processing, 600
- photopigments, 96, 98
- photoreceptors, 90–96, 91, 92
 - receptive fields, 106
 - response to light, 98–105, 99, 100
- physical activity, 236, 257, 536
- physiological processes, 232–235, 241–244
- pia mater, 22
- pineal gland, 2, 3, 33
- pituitary gland, 32, 275, 297, 298, 299.
 - See also* hypothalamic–pituitary–adrenal (HPA) axis
- place cells, 363–365
- place fields, 363, 364
- plasticity, 4, **8**, 11, 322
 - adapting to input changes, 325–331, 327, 328, 330
 - central nervous system injuries, 335–336
 - expansion of brain regions, 322–325, 324, 325
 - key contributors to, 332–335, 334
 - reward, 473–478
 - synaptic, 369–377, 370, 371, 373, 374, 380, 386, 388
 - treatments for nervous system injuries, 337–343, 340
- pleasure. *See* hedonic properties
- pluripotent cells, 310
- polarized neurons, 55
- polymodal nociceptors, 130
- pons, 26, 28, 180, 215–216, 223, 388
- pop-out effects, 403, 404, 405
- positive reinforcement, 443
- postcentral gyrus, 162
- posterior brain, location, 17, 18
- posterior cingulate cortex, 604

628 INDEX

- posterior parietal cortex, 168, 424, 424
- post-ganglionic nerves, 488
- postsynaptic neurons, 63–64, 64, 66, 73, 76, 332, 333, 370, 370, 371, 386, 461
- posttraumatic stress disorder (PTSD), 388, 485–486, 497, 510, 511, 511, 517
- potassium ions (K⁺), 51, 58, 98, 468
- prairie voles, 299, 299
- precentral gyrus, 160, 162
- precuneus, 607, 607
- precursors, neural, 62
- prefrontal cortex, 40, 173–176, 175, 380, 381, 428–429, 429
 - anxiety, 517, 517
 - brain development, 319, 319
 - depression, 532
 - dopamine, 448, 453
 - drug reward, 470, 471
 - hunger, 249
 - movement, 146
 - myelin, 60
 - working memory, 424, 432
- preganglionic nerves, 488
- premotor areas, 159, 167, 168, **169–170**
- preoptic area, 213
- presenilin, 566, 566
- presynaptic neurons, 63–64, 64, 73, 79, 332, 333, 370, 371, 461
- primary auditory cortex, 128
- primary motor cortex, 146, 158–166, 159, 162, 163
 - skill learning, 379–380, 380, 381
- primary olfactory cortex, 134
- primary reinforcers, 443
- primary somatosensory cortex, 131, 133, 165
- primary visual cortex, 105, 111–114, 114
 - blindness, 121
 - columns of neurons, 117, 118
- progenitor cells, 311
- progesterone, 281
- prosopagnosia, 120
- protein synthesis, 73, 386
- protein synthesis inhibitors, 387
- proteins, 235
- Prozac, 80, 264, 514, 533
- psychoactive drugs, 78–80
- psychoanalytic therapy, 263
- puberty, 281, 297
- pupil, 89
- pure word blindness, 600
- pure word deafness, 597
- Purkinje cells, 183, 184
- pyramidal neurons, 160
- quadriplegia, 149
- radial glia, 7, 312
- Raisman, Geoffrey, 326
- Ramon y Cajal, Santiago, 320
- rapid eye movement (REM), 192, 201, 201, 224. *See also* dreams
 - age and species variations, 203–205
 - brainstem, 214–217, 215
 - narcolepsy, 220
 - REM sleep behavior disorder (RBD), 223
- Rasmussen's disease, 325
- rational emotive behavioral therapy (REBT), 513, 534–535
- readiness potential, **169–170**, 170
- reappraisal, 513–514, 514
- receptive fields, 106–110, 107, 114, 114, 117
 - touch perception, 129
- receptors, 5, 63–64, 64, 69, 78–80, 78. *See also* photoreceptors
 - dopamine, 418, 464, 547
 - ghrelin, 242, 246
 - glucocorticoid, 497–501, 515, 515–517, 516
 - glutamate, 333–335, 336, 369–375, 476
 - ionotropic and metabotropic, 72–73, 74
 - nicotinic, 466
 - olfactory, 133–136
 - opioid, 467
 - somatosensory, 129–131, 130
 - taste, 136
- reciprocal excitation, 357
- reconsolidating memories, 387
- recurrent connections, 76, 77, 429
- reflex, 46, 47, 74, 156
- refractory periods, 59
- rehearsal, 422

- reinforcement, 29, 440. *See also* drug reward
 - dopamine and electrical stimulation, 448–450, 449
 - dopamine and food reward, 452, 455–456
 - electrical stimulation overview, 445–446, 447
 - financial, social, and sexual reward, 456–458, 456, 458
 - learning and plasticity, 473–478, 475
 - reward-related learning, 440–444, 441, 442, 443
- relay nucleus, 111
- repolarization, 58–59, 58
- resilience, to stress, 496–497, 496
- resting potential, 55
- resting tremor, 551
- restrained eaters, 245
- reticular nucleus, 213
- retina, 89, 326. *See also* vision
- retinal disparity, 120
- retinal pigment epithelium, 90
- retrieval cues, 357
- retrograde amnesia, 355–356, 355
- retrograde messengers, 374
- reuptake pumps, 79
- reverberatory activity, 76, 429
- reward, 439–440. *See also* drug reward
 - dopamine and electrical stimulation, 448–450, 449
 - dopamine and food reward, 452–456, 455
 - electrical stimulation overview, 445–446, 447
 - financial, social, and sexual reward, 456–458, 456, 458
 - learning and plasticity, 473, 475, 477–478
 - reward-related learning, 440–444, 441, 442, 443
- reward prediction error, 456
- reward processing, 255
- right hemisphere, 16, 37, 580–582, 583
 - split-brain surgery, 582–587, 583, 585
 - visual system, 102, 585–587, 586, 587
- rigidity, 551
- rods (photoreceptors), 90–94, 92, 94
- Röntgen, Wilhelm, 19
- rostral. *See* anterior brain
- Rubens, Peter Paul, 252, 252
- Ruffini endings, 129
- rumination, 490
- sacral division, 148
- sagittal plane, 18, 19, 31, 361, 583
- Salamone, John D., 453
- salient stimuli, 403, 404, 408, 548, 553
- saltatory conduction, 59, 60–61
- satiety, 240, 242, 243–244
 - hypothalamus’ role, 245–250, 247
- schizophrenia, 539–540, 543
 - antipsychotic drugs, 546–549, 547
 - brain structure and function, 545–546, 545
 - genetic and environmental influences, 543–545, 543
 - psychological therapy, 549
 - symptoms, 540–542
- Schwann cells, 7, 338
- scotoma, 121
- sea slugs (*Aplysia*), 390–392, 391
- second messengers, 73
- secondary somatosensory cortex, 131
- secondary visual cortex, 114
- selective attention, 400
- selective serotonin reuptake inhibitors (SSRIs), 514, 518, 532, 533, 534
- semantic content, 590
- semantic memory, 350, 351, 352
- sensorineuronal hearing loss, 129
- sensory information, 12–13, 28, 31, 213
- sensory neurons, 46, 48, 53, 75, 86, 357, 391
- sensory systems, 86, 87. *See also* vision
 - audition (hearing), 123–129
 - gustation (taste), 132, 136, 137
 - olfaction (smell), 132–136, 135
 - somatosensation, 129–131, 132, 133
- septal nuclei, 326, 327
- serial search strategies, 404
- serotonin, 27, 62, 66, 211, 258, 264, 514
 - depression, 532, 533–534
 - psychoactive drugs, 79
 - sex, 299
- serotonin transporter proteins, 533
- serotonin-norepinephrine reuptake inhibitors (SNRIs), 533

630 INDEX

- sex, 273–274
 - animals’ sexual behavior, 286–288, 287
 - gender identity and behavior, 288–290
 - hormonal influence, 274–277, **276**, 277, 278, 297–300
 - male and female brains, 283–286, 284
 - masculinization of sex organs, 280–282, 282
 - sexual orientation, 292–294
 - sexual stimuli, 295–296
 - SRY gene, 279–280
 - transsexual and transgender individuals, 290–291
- sex-determining protein, 280
- sexual dimorphisms, 283–286
- sexual organs, 289, 291, 297
- sexual orientation, 292–294
- sexual reward, 457
- sexually dimorphic nucleus (SDN), 284, 284
- shaping by successive approximations, 440, 441
- Siffre, Michel, 193
- signals, electrical, 46–49, 48, 131, 401
- signal-to-noise ratios, 401, 402, 403
- simple cells, 113, 114
- simultaneous bilinguals, 601
- single-neuron recording, **22**, 106
- single-unit recording, 106
- skeletal muscle, 150, 152
- skill learning, **351**, 351, 354, 378–382, 380
- sleep apnea, 222, 222
- sleep paralysis, 221
- sleep-on neurons, 213
- sleep–waking, 191–192
 - age and species variations, 202–205, 203, 204, 205, 206, **206**
 - benefits of sleep, 223–224
 - brain mechanisms, 210–217, 210, 211, 215, 216, 217
 - circadian rhythms, 192–197, 194
 - dreams, 207–209
 - insomnia, 218–220
 - narcolepsy, 220–222
 - REM sleep behavior disorder, 223
 - sleep apnea, 222, 222
 - stages of sleep, 197–201, 198, 201, 202
- slow-wave sleep, 201, 214, 365
- small intestine, 236, 243, 260
- smell, 132–136, 135
- smooth muscle, 150
- Snowdon, David, 527
- social anxiety disorder, 510
- social cognitive neuroscience, 607–608, 608
- social reward, 457, 458
- sodium channels, 51, 52, 73, 75, 80, 98, 151, 335, 450
- sodium ions (Na⁺)
 - action potential, 56–59, 57, 58
 - depolarization, 55–56, 73, 98, 372, 373
 - factors causing, 51–54, 52, 53, 333
 - firing threshold, 55–56
 - muscle fibers, 151
 - neurotransmitters, 69–70, 71, 75
 - saltatory conduction, 59–61, 60
- sodium-potassium pump, 54, 59
- solitary nucleus, 136, 246
- somatic nervous system, 12–14
- somatosensation, 13, 129–131, 132, 133, 133, 401, 402
- somatosensory cortex, 323, 324
- somatotopic organization, 160, 163
- sound localization, 126
- sound waves, 123, 124, 590, 590
- spatial information, 421
- spatial summation, 69
- specific phobia, 510
- speech comprehension, 594–598, 595, 596, 597
- speech production, 590–592
- sperm, 279, 279
- Sperry, Roger, 314, 584, 587
- spikes, 58, 61
- spinal cord, 3, 22–26, 23, 24, 25
 - local spinal cord neuron, 47
 - movement, 148–158, 149, 150, 151, 152, 160, 166
 - receptors, 75
 - sleep–waking, 216
 - somatosensation, 131
 - structure, 16–19, 18
 - surgical treatment, 342–343
 - sympathetic nerves, 14
- split-brain surgery, 579–580, 582–587, 583, 585
- spontaneous recovery, 506, 512
- SRY gene, 279–280, 285

- stability, physiological, 496
 standard model of memory
 consolidation, 360
 startle response, 390
 stem cells, 310, 320, 559
 steroids, 276, 278
 stimulant drugs. *See* amphetamine;
 cocaine
 stimulus-driven attention, 403, 404,
 406–409, 406, 409, 413
 stomach, 236, 243, 246, 260
 stop-signal task, 471, 472
 stress, 249, 485–486
 brain's response to, 490–491, 491,
 492
 depression, 530
 early life experiences, 497–501, 498,
 500
 glucocorticoids, 515–518, 515, 516,
 517
 hypothalamic–pituitary–adrenal (HPA)
 axis, 488–490, 489
 immune system, 493–496, 495
 resilience and recovery, 496–497, 496
 sympathetic nervous system, 487–488,
 487
 stressors, 486. *See also* stress
 striated muscle, 150
 striatum, 34, 177–180, 178, 179, 342,
 381, 448
 Parkinson's disease, 552
 reward, 453, 457, 465, 470, 473–478,
 475, 477
 strokes, 335, 590
 Stroop task, 414–417, 415
 substantia nigra, 29, 34, 66, 177, 342,
 446, 453, 454, 473, 552
 subthalamic nucleus, 558, 558
 successive bilinguals, 601
 sulci, 37, 37, 309
 superior brain. *See* dorsal brain
 superior colliculus, 29, 104, 104, 121
 superior olive, 126, 128
 superior temporal gyrus (STG), 595–597,
 595, 596, 601
 supplementary motor area (SMA), 4,
 167–171, 168
 suprachiasmatic nucleus (SCN), 105,
 195–196, 195, 213
 surgical treatments, 341–343
 surprising stimuli, 407–409, 407
 sympathetic nervous system, 14–16, 15,
 35
 hunger, 249
 sleep–waking, 201, 208
 stress, 487–488, 487, 490, 491, 495
 synapse, 80, 460–462. *See also* synaptic
 plasticity
 synaptic cleft, 5, 46, 47, 62–64, 63, 64,
 65, 369
 synaptic plasticity, 332–335, 369–377,
 370, 371, 373, 374, 386, 388
 synchronized neurons, 199, 212
 synergistic muscles, 154
 synesthesia, 122
 syntax, 589, 593–594
 synthesis, neuronal, 62
 systematic desensitization, 512–513
 tastants, 132
 taste, 132, 136, 137
 taste reactivity, 453
 tau protein, 564, 565
 TE (ventral stream area), 119
 tectorial membrane, 124
 temperature changes, 131
 temporal cortex, 349–350, 595, 595–597,
 597
 temporal lobe, 39, 119, 120, 134. *See also*
 medial temporal lobe
 temporal summation, 69
 temporally graded amnesia, 356
 temporoparietal junction, 406, 413, 607,
 607
 tendons, 150, 152, 155
 TEO (ventral stream area), 119
 terminals, 5, 6, 46–49, 48, 57, 58, 62, 75,
 450
 testes, 275, 280, 281, 282, 297
 testosterone, 275–277, 277, 280, 281,
 284–285, 287, 289–290, 297
 thalamic relay neurons, 213
 thalamocortical neurons, 216
 thalamus, 31–32, 31, 111, 126, 136
 fear conditioning, 384, 385
 sensory systems, 131, 326
 sleep–waking, 192, 210–212, 210, 213,
 214, 216–217, 217
 theory of mind, 606
 thermoreceptors, 130, 131

632 INDEX

- thermostats, 233–234, 233
- thoracic division, 148, 150
- thought disorders, 541
- tiling, retinal, 110, 110
- tissue restoration, 342
- tonotopic organization, 126, 127
- top-down attention. *See* goal-directed attention
- touch, 129, 130
- touch-sensitive nerves, 12
- toxins, 336
- tranquilizing chair, 546
- transcranial magnetic stimulation (TMS), 537, 538
- transduction, 86
- transgender individuals, 290–291
- transporter proteins, 64
- transsexual individuals, 290–291
- traumatic brain injury (TBI), 335
- tricep muscle, 153, 154
- tricyclic antidepressants, 533
- triglycerides, 239
- tryptophan, 62
- tumors, 336
- two-sided brain. *See* hemispheres
- tyrosine, 62

- umami taste, 136
- unconditioned response (UR), 383
- unconditioned stimulus (US), 383, 386, 443, 444, 502
 - fear, 505–508
- undifferentiated cells, 312
- unihemispheric sleep, 205
- unipolar depression. *See* depression
- upper motor neurons, 160
- utilization behavior, 174

- V1. *See* primary visual cortex
- V2. *See* secondary visual cortex
- V4 (ventral stream area), 119
- vagus nerve, 243, 246, 488
- Valium (Diazepam), 66, 219
- ventral brain, location, 18, 19
- ventral frontal cortex, 406
- ventral horns, 150, 151
- ventral motor area, 168
- ventral posterior nucleus, 131, 136
- ventral premotor cortex, 167, 172

- ventral stream, 116–117, 116, 119–120
 - audition (hearing), 128
 - goal-directed attention, 410–411, 410
- ventral tegmental area (VTA), 29, 446, 449, 450, 453, 454, 466, 477
- ventral thalamus, 177, 178
- ventricles, 23, 25, 545, 545
- ventricular zone, 311, 311, 312
- ventromedial PFC (vmPFC), 508, 508, 511, 511, 514
- vertebrates, 16, 309
- vesicles, 62
- Viagra (sildenafil), 300
- visible light, 88, 89
- vision, 32, 87
 - brain hemispheres, 585–587, 586, 587
 - columns of neurons, 117, 118
 - functions of cortical areas, 119–122
 - goal-directed attention, 410–411, 410, 412
 - higher-order visual areas, 116–117, 116
 - light reaching the retina, 88, 91, 92, 95–96
 - photoreceptors responding to light, 98–105, 99, 99, 100, 103
 - visual stimuli, 106–114, 107, 114, 326–331, 328, 330, 421
- visual association areas, 116–117, 116
- visual saccades, 175
- visual word form area, 600, 600
- visuomotor neurons, 172
- visuospatial neglect, 413–414
- visuospatial sketch pad, 421
- vitamin B-1, 355
- voltage-gated channels, 55–59, 57, 73
- voltmeters, 54
- vomeroneasal organ, 296
- Von Economo, Constantin, 213

- waking-on neurons, 212, 215, 221
- waste products, 224
- weight loss, 256–260
- weight regulation, 250–251. *See also* obesity
- Wernicke, Carl, 594
- Wernicke's aphasia, 592, 594, 597
- Wernicke's area, 594, 595

white matter, 10, 11, 37, 150, 151, 471, 472	neuron activity in monkeys, 422–427, 423, 424, 425
Wiesel, Torsten, 113–114	perception comparison, 430–431, 431
Wirtshafter, David, 251	reasons for failure, 427–429, 428, 429
Wise, Roy, 449	World Health Organization (WHO), 253
withdrawal reflex, 156	
Wolffian duct, 280, 282	Xanax, 66, 514
word comprehension, 598, 598	x-rays, 19
working memory, 76, 354, 400, 420–421	XY chromosomes, 280, 289, 290, 293
Baddeley and Hitch model, 421–422, 422	
future questions, 432	zeitgebers (time-givers), 193
neuron activity during delay periods, 429–430, 430	Zolof, 80, 533
	zygote, 279, 279, 308