Index

A

ABA. See Abscisic acid Abscisic acid (ABA), 111–112 AC. See Adendylyl cyclase Acetylcholine, Drosophila sleep homeostasis studies, 90–91 AD. See Alzheimer's disease Adendylyl cyclase (AC), 75–76 Alzheimer's disease (AD), sleep disorders, 78–79 AMPK, 49 Arabidopsis. See Plant circadian clock Arginine vasopressin (AVP), suprachiasmatic nucleus synchronization, 58–59 AUF1, 160 AVP. See Arginine vasopressin

В

BK channel, 71, 77–78 Black-box experiments, 3 BMAL carbon monoxide depletion and CLOCK-BMAL up-regulation, 31 depletion in arginine vasopressin cells, 60–61 history of study, 45–46, 213–214 hypoxia-inducible factor-1α interactions, 31–32 mammalian clock model, 142, 196 neuronal activity regulation, 76–78 SIRT and CLOCK-BMAL1 complex interactions, 27–28, 34, 143 transcriptional regulation, 143–144 translation efficiency regulation, 148 translational regulation, 160

С

cADPR, 109 Calmodulin, 73 Carbon monoxide, depletion and CLOCK-BMAL up-regulation, 31 Casein kinase (CK) circadian clock model of *Drosophila*, 177–178, 180 CK2 expression differences in *Drosophila* models, 183–184, 186 PER degradation role, 48–50 phosphorylation in clock period setting, 126–129, 132 Catalase, oscillations, 28 CCA1, 28, 106-111, 113, 123, 129 CCNN. See Circadian clock neuronal network CIRBP, 147, 157-158 Circadian clock neuronal network (CCNN) circadian clock model of Drosophila CRY function, 181-182 kinases casein kinase II, 180 Doubletime, 179-180 Nemo, 181 protein kinase A, 181 Shaggy, 180-181 negative feedback loop, 177-178 relating to circadian clock neuronal network CRY expression differences, 184-185 kinases, 182-184 local clock regulation, 186-187 Nemo expression differences, 184 overview, 182 PER effects on different clocks, 185 promoter activity, 185-186 transcriptome oscillations, 178 CRY-PDF function intersection, 176-177 dorsal lateral neurons an fifth s-LNV, 174-175 dual oscillator model, 168, 170-171 evening anticipation, 175-176 eve input, 171 ion transport protein, 176 neuropeptide F, 175-176 overview, 168-169 short-neuropeptide F, 176 ventral lateral neurons and pigment-dispersing factor, 172-174 Circadian rhythm definition, 4 properties, 5 CK. See Casein kinase CLK, 175-176 CLOCK carbon monoxide depletion and CLOCK-BMAL up-regulation, 31 circadian clock model of Drosophila, 177-178 circadian clock neuronal network, 168 history of study, 45, 214 mammalian clock model, 142, 196 neuronal activity regulation, 76, 78

Index

CLOCK (Continued) PARP1 binding, 27 SIRT and CLOCK-BMAL1 complex interactions, 27-28, 34, 143 transcriptional regulation, 143 Clock, components, 7 COI1, 113 CPEB2, 162 CREB, 91 CRISPR-Cas9, 144 CRTC1, 54 CRY circadian clock model of Drosophila, 181-182 circadian clock neuronal network, 168, 171-172 Drosophila model expression differences, 184-185 history of study, 214 mammalian clock model, 16, 142 neuronal activity regulation, 76 period setting for circadian rhythms, 47-50 phosphorylation in clock period setting, 128-129, 131 pigment-dispersing factor function interactions, 176-177 redox control, 30 suprachiasmatic nucleus neuronal excitability regulation, 50 transcription negative feedback in oscillators, 122-124 translational regulation, 161 CTCF, 144-145 CYC circadian clock model of Drosophila, 177-178 circadian clock neuronal network, 168

D

DBP, 141 DBT. See Doubletime Dicer, 161 Dopamine, Drosophila sleep homeostasis studies, 91–92 Doubletime (DBT), circadian clock model of Drosophila, 179–180 Drosophila. See Circadian clock neuronal network; Sleep homeostasis

Ε

EEG. *See* Electroencephalography EGF. *See* Epidermal growth factor Electroencephalography (EEG), slow wave activity in mammalian sleep homeostasis, 87–90 Epidermal growth factor (EGF), 93

F

Fast delayed rectifier potassium current, 71 FBXL3, 48–49 FER1, 110
Fmr1, 160
Free-running period (FRP) definition, 4 temperature compensation, 6–7
FRP. See Free-running period
FRQ phosphorylation in clock period setting, 129, 131 transcription negative feedback in oscillators, 122, 124

G

GABA *Drosophila* sleep homeostasis studies, 92–93 sleep induction, 97 suprachiasmatic nucleus synchronization, 57–58 *GIGANTEA*, 107–108, 110 Glutathione (GSH), oscillations, 15, 26–27 Glutathione peroxidase, oscillations, 28 GSH. *See* Glutathione GSK3β, 126–128, 177, 180–181 Gut microbiome, diurnal changes and body rhythms, 202–203

Н

HD. See Huntington's disease Heme, carbon monoxide loop, 31 Herpes viruses, clock priming of immune function, 198 HIF1α. See Hypoxia-inducible factor-1α Historical perspective chronobiology studies, 2-3 clock gene studies, 45-46 nontranscriptional oscillator studies, 11-16 Huntington's disease (HD), sleep disorders, 79 Hydrogen peroxide peroxiredoxin proteins scavenging, 16-19 signaling mediation, 21-22 redox control over transcriptional clock, 29 Hypoxia-inducible factor- 1α (HIF 1α), BMAL1 interactions, 31-32

I

IDR. See Intrinsically disordered region Immune function clock priming against pathogens herpes viruses, 198 influenza virus, 198 Listeria monocytogenes, 200 Salmonella typhimurium, 200 Sendai virus, 199 Streptococcus pneumoniae, 198–199

Index

vesicular stomatitis virus, 199 environmental challenge anticipation by endogenous clock, 196–197 gut microbiome diurnal changes and body rhythms, 202–203 healthy lifestyle contributions, 200–202 inflammatory response circadian gating, 197–198 Inflammatory response circadian gating, 197–198 Influenza virus, clock priming of immune function, 198 Intrinsically disordered region (IDR), multisite phosphorylation, 131 Ion transport protein (ITP), 176 ITP. See Ion transport protein

J

JET, 184

K

Kai proteins history of study, 214 KaiC phosphorylation, 124–126, 130–132 oscillations in cyanobacteria, 16 Kir2.1, 73–74 KSRP, 160

L

LARK, 160 LHY, 106–107, 109–111, 12 Listeria monocytogenes, clock priming of immune function, 200

Μ

Melatonin, antioxidant activity, 28–29 MicroRNA, translational regulation, 161 mTORC1, 159

Ν

NAD. See Nicotinamide adenine dinucleotide NALCN, 52, 70 NAMPT. See Nicotinamide phosphoribosyltransferase Nemo (NMO) circadian clock model of *Drosophila*, 181 circadian clock neuronal network, 184 Neuropeptide F (NPF), 175–176 Nicotinamide adenine dinucleotide (NAD).oscillations in redox couples, 25–26 Nicotinamide phosphoribosyltransferase (NAMPT). clock-mediated control, 27–28 NMDA, *Drosophila* sleep homeostasis studies, 92 NMO. See Nemo Nocturnin, 147 NONO, 158 Non-rapid eye movement (NREM) sleep, slow wave activity in mammalian sleep homeostasis, 87–90 NPAS2, 30–31 NPF. *See* Neuropeptide F NREM sleep. *See* Non-rapid eye movement sleep NRF2, oscillations, 26–27, 30

0

Opn4, 157

Р

Pacemaker, clock coordination, 7-8 Parkinson's disease (PD), sleep disorders, 79 PARP1 CLOCK binding, 27 oxidative stress in activation, 30 PD. See Parkinson's disease PDF. See Pigment-dispersing factor PDI. See Protein disulfide isomerase Pentose phosphate pathway (PPP), 33 PER casein kinase in degradation, 48-50 circadian clock model of Drosophila, 177-180 circadian clock neuronal network, 168, 170 Drosophila effects on different clock models, 185 history of study, 213-215 mammalian clock model, 16 neuronal activity regulation, 76, 78 period setting for circadian rhythms, 47-49 phosphorylation in clock period setting, 128, 131-132 suprachiasmatic nucleus neuronal excitability regulation, 50-51, 53 transcript processing, 156-157 transcription negative feedback in oscillators, 122 - 124translational regulation, 159-161 Peroxiredoxin proteins (PRDXs) hydrogen peroxide scavenging, 16-19 signaling mediation, 21-22 hyperoxidation and signaling, 21, 23-24, 32, 34 protein disulfide isomerase interactions, 25 red blood cell oscillations, 16 redox relay signaling, 25 S-sulfinylation circadian oscillations, 19-21 Phase-response curve (PRC), 4-5 Phosphorylative modification KaiC, 124-126, 130-132 multisite phosphorylation in clock period setting CCA1, 129

Index

Phosphorylative modification (Continued) CRY, 128-129 flexible protein regions, 130-132 FRQ, 129, 131 kinases, 126-128 overview, 126 PER, 128 temperature compensation, 129-130 overview, 121-122 transcription negative feedback in oscillators, 122-124 Pigment-dispersing factor (PDF), 76, 172-177 PKA. See Protein kinase A Plant circadian clock Arabidopsis clock organization genes, 106-107 wiring, 107-108 hormone pathways, 111-112 master regulation, 113-115 metabolism calcium, 109 carbohydrates, 108-109 copper, 110-111 iron, 109-110 nitrogen, 109 overview, 105-106 stress abiotic, 112-113 biotic, 113 Posttranscriptional regulation nuclear export of transcripts, 158 overview, 155-156 poly(A) tail length, 161-162 primary transcript processing, 156-157 systems chronobiology, 145-147 translational regulation, 159-161 Posttranslational oscillator (PTO), 124, 126 PPP. See Pentose phosphate pathway PRC. See Phase-response curve PRDXs. See Peroxiredoxin proteins Protein disulfide isomerase (PDI).peroxiredoxin interactions, 25 Protein kinase A (PKA), 76, 176, 181 PRR genes, 107, 112-113 PSPC1, 158 PTO. See Posttranslational oscillator

R

RBM14, 158 RBM3, 147, 157 RCA, 108 REB, 75 REV-ERB α , 30, 46, 77, 142 RGS16, 76 Rosbash, Michael, recollections of circadian rhythm research, 207–216

S

Salmonella typhimurium, clock priming of immune function, 200 SCN. See Suprachiasmatic nucleus Sendai virus, clock priming of immune function, 199 SETX, 157 SFPQ, 158 SGG. See Shaggy Shaggy (SGG), circadian clock model of Drosophila, 177, 180-181 Short-neuropeptide F (s-NPF), 176 Sik1, 54 SIRT, CLOCK-BMAL1 complex interactions, 27 - 28, 34Sleep homeostasis Drosophila neurotransmitter studies acetylcholine, 90-91 dopamine, 91-92 GABA, 92-93 NMDA, 92 overview, 90 growth and differentiation pathway role, 93 immune function sleep effects on immune response, 95-96 sleep mediation, 94-95 metabolism interaction cellular metabolism, 97 sleep effects on metabolic status, 96-97 systemic effects of sleep loss, 96 overview, 85-87 slow wave activity in mammals, 87-90 unfolded protein response, 93 s-NPF. See Short-neuropeptide F SOD. See Superoxide dismutase STAT3, redox relay signaling with peroxiredoxins, 25 Streptococcus pneumonia, clock priming of immune function, 198-199 Superoxide dismutase (SOD), oscillations, 28 Suprachiasmatic nucleus (SCN) cell-autonomous timekeeping, 44-45 circuitry, 46-47 ion channels action potential activation of signaling pathways, 73 - 76aging and disease effects on neuronal activity, 77-79 clock gene regulation of neuronal activity, 76-77 daily depolarization, 70 frequency modulation, 71 neuronal heterogeneity, 72-73 nightly silencing, 71-72 signaling domains, 69-70 lesion studies, 8, 44 molecular clockwork control, 53-54

Index

neuronal excitability regulation, 50-53 speed setting, 47-50 synchronization, intrinsic mechanisms arginine vasopressin, 58-59 GABA, 57-58 overview, 54-55 pacemaker cells, 59-63 vasoactive intestinal peptide, 55-57 ZFHX3, 59 Systems chronobiology, global analysis of gene regulation constraints on transmission of rhythmic information, 140-141 core clock model, 142 posttranscriptional regulation, 145-147 prospects, 148 protein accumulation rhythms, 148-149 rhythmic transcription in three-dimensional nucleus, 144-145 statistical analysis, 141-142 temporal gene regulation, 139, 141 transcriptional regulation of clock genes, 143-144 translation efficiency regulation, 148

Т

Temperature compensation, 6–7, 129–130 TIM circadian clock model of *Drosophila*, 177–178, 180 circadian clock neuronal network, 168 history of study, 215 *TOC1*, 106–107, 112 Transcriptional/translation feedback loop (TTFL), 12, 16, 30–31, 47, 54, 58–59, 63, 122–124, 126, 142 TRPA1, 92 TTFL. *See* Transcriptional/translation feedback loop

U

Unfolded protein response (UPR), sleep homeostasis, 93 UPR. *See* Unfolded protein response

V

Vasoactive intestinal peptide (VIP), suprachiasmatic nucleus synchronization, 55–57, 75 Vesicular stomatitis virus (VSV), clock priming of immune function, 199 VIP. *See* Vasoactive intestinal peptide VSV. *See* Vesicular stomatitis virus

W

WCC, transcription negative feedback in oscillators, 122

Ζ

ZFHX3, suprachiasmatic nucleus synchronization, 59 ZTL, 110