

# INDEX

## A

- Acetylcholine ..... 27  
 Achromatopsia ..... 102  
 Adeno-associated virus (AAV)  
   capsid ..... 84, 85, 87, 92, 94–96, 102  
   manufacturing ..... 85  
   recombinant adeno-associated viral vectors  
     (rAAVs) ..... vi, 2, 4, 5, 7, 14, 83–98  
   titration ..... 85  
   vectors ..... 102  
 Adenosine 5'-triphosphate (ATP) ..... 13, 22,  
   120, 238  
 Adenovirus ..... 86  
 Adenylyl cyclase  
   padenylyl cyclases (PACs) ..... 30  
 Affinity chromatography ..... 85, 218, 223  
 Agarose ..... 5, 8, 56, 67, 221, 228  
 Anesthesia ..... 4, 5, 7, 77, 78, 80, 103, 105, 110  
 Antibiotic ..... 54, 58, 77, 90,  
   103, 104, 106, 109, 191, 195, 250–253  
 Antibodies ..... 6, 14, 15, 28, 55, 60, 67, 76, 79, 84, 110, 206,  
   212, 245, 265  
 Anti-CRISPR (Acr) protein  
   AcrIIA4 ..... 138, 275, 276  
 Apoptosis ..... 160, 166, 167  
*Arabidopsis thaliana* ..... 171, 263  
 Artificial cerebrospinal fluid (ACSF) ..... 5, 6, 8,  
   10, 13, 55, 56, 60, 63, 64, 66  
 Astrocytes ..... 53–68, 79  
*A. thaliana*, *see Arabidopsis thaliana*  
 Autocamtide inhibitory peptide 2 (AIP2) ..... 32  
 Autoinhibitory domains ..... 121  
*Avena sativa* ..... 113, 128, 138, 160, 171, 265, 275  
 Azobenzene ..... 25, 28

## B

- Beggiatoa* ..... 30  
 Bertin's quadrant ..... 107, 111  
 BID ..... 160–162, 165, 167, 169  
 Blue light sensor using FAD (BLUF) ..... 30  
 Brain  
   slice ..... vi, 2, 3, 5, 6, 8–12, 15, 16, 59, 63, 64  
 Bregma ..... 8, 57, 76

## C

- Calcium (Ca<sup>2+</sup>)  
   channels ..... 23  
   signaling ..... 30, 54, 63, 190  
   imaging ..... 56, 62–63  
 Calmodulin dependent kinase II (CaMKII) ..... 23,  
   32, 33, 38, 39  
 Cdc42 ..... 116  
 cDNA ..... 89, 96  
 Cerebellum ..... 58  
 Cesium chloride (CsCl)  
   density gradients ..... 85  
   gradient centrifugation ..... 85  
 Channel  
   G protein-gated GIRK ..... 33  
   leak potassium ..... 33  
   ligand-gated cation ..... 33  
   TREK1 channels ..... 33  
   voltage-gated potassium ..... 33  
 Channelrhodopsin-2 (ChR2), *see* Opsin  
 Chromatin ..... 171–186,  
   262, 265, 266  
 Chromophore ..... 27, 29, 32, 37, 71,  
   128, 162, 190, 223, 224, 229, 256, 274  
 CIB ..... 29, 30, 32  
 Cloning ..... 86, 89, 90, 95, 96  
 Color vision ..... 101  
 Coomassie ..... 223, 224  
 Cortex ..... 58, 78  
 Cph1 ..... 218–229  
 Craniotomy ..... 57, 58, 77, 78, 80, 81  
 Cre ..... 16, 151  
 CRISPR  
   Cas9 ..... 84, 137, 138, 261,  
     263–268, 270  
   Cas12 ..... 275  
   Cas13 ..... 262  
   interference (CRISPRi) ..... 266  
   labeling ..... vi, 137–149, 275  
 Cryptochrome  
   CRY2 ..... 29, 151, 263  
 Cyclic adenosine monophosphate  
   (cAMP) ..... 22, 23, 30, 38, 201–213

**D**

DAPI..... 55, 59–61, 76, 79, 134,  
140, 142, 144–146, 148, 149  
Deep brain stimulation .....71–81  
Degron..... 151–157, 159, 160, 162  
Designer Receptors Exclusively Activated by Designer  
Drugs (DREADD)..... 27, 39, 53  
Differentiation..... 23, 32, 201, 233, 267, 274  
Domain ..... 3, 28, 30, 32, 33, 35,  
37–39, 84, 89, 107, 113–115, 117–123, 128,  
132, 135, 138, 152, 153, 160, 162, 171, 172,  
203, 212, 234, 244, 262, 263, 265, 266, 268,  
269, 271, 274, 275  
Dopamine ..... 38, 72, 75, 77, 79, 81  
Dronpa..... 32, 269  
Droplet digital (dd) PCR .....85, 94  
*Drosophila* .....27, 116, 243

**E**

Electrode ..... 2, 4, 6, 12, 75, 78, 251  
Electrophysiology  
electrophysiological recordings ..... 56, 63–65  
Emission .....6, 72, 73, 75, 77,  
80, 81, 140, 172, 175, 177, 181, 206, 210, 211,  
245, 252, 255, 257  
Enzyme linked immunoabsorbant assay  
(ELISA)..... 94, 204, 206, 208, 209, 212  
ERK ..... 23, 24, 30, 32,  
38–40, 233, 242, 243, 245  
*Erythrobacter litoralis*..... 160  
*Escherichia coli* (*E. coli*).....86, 90, 218,  
222, 223, 227, 250, 252, 268, 271  
*Euglena gracilis*..... 30  
Excitation..... 3, 6, 16, 17, 27, 62,  
72, 79, 81, 132, 134, 143, 156, 157, 171–173,  
175, 177, 183, 184, 210, 211, 224, 242, 245,  
252, 257, 263, 266  
Extracellular matrix..... 217–230  
Eye ..... 4, 7, 84, 85, 97,  
102, 105–107, 109, 243

**F**

Fast-scan cyclic voltammetry .....73, 75, 78  
Fiber..... 2, 3, 10, 12, 14, 55, 58,  
60, 63, 64, 67, 73, 75–78, 80, 81, 111  
Flavin ..... 29, 32, 114, 128  
Fovea  
foveal cones ..... 101–111  
Förster resonance energy transfer  
(FRET)..... 35, 37, 39

**G**

GDP ..... 22  
Gene  
delivery.....84, 101–112, 262, 272, 277  
editing .....40, 84, 277  
expression ..... 37, 84, 85, 95,  
102, 128, 138, 151–157, 172, 189–198, 251,  
263, 265, 272, 274  
therapy .....84, 102, 277  
transfer vectors ..... 84  
Genome  
editing .....261, 264, 275, 277  
Glial fibrillary acidic protein (GFAP)..... 54, 59,  
62, 79  
G protein  
G $\alpha$  ..... 22, 23, 30  
G $\beta$ ..... 22, 34  
G $\gamma$ ..... 22, 34  
GTP .....13, 22  
GTPases ..... 23, 29, 30, 32,  
33, 115–117, 121, 123  
Green fluorescent protein (GFP)  
circularly-permuted GFP  
(cpGFP) ..... 35, 37, 38  
Guanine exchange factors  
(GEFs).....117, 121–123

**H**

HeLa .....130, 145, 256, 272  
Hemisphere .....8, 78  
High-throughput screening .....vi  
Human embryonic kidney (HEK) ..... 272  
Hydrogels .....218, 222, 224–229

**I**

ImageJ.....63, 79, 130, 131, 175, 177, 180  
Imaging..... 36, 37, 40, 56,  
62, 102, 105, 109, 110, 134, 138–140, 143, 146,  
153, 154, 172, 176, 178, 183, 184, 204, 206,  
210–213, 228, 235, 248, 249, 258  
Immunohistochemistry ..... 14, 59, 73, 79  
Immunostaining.....17, 59  
Induced pluripotent stem cells (iPSCs) ..... 190, 267  
Injection  
intravitreal ..... 102, 103, 105–106  
subretinal .....102, 104–111  
Interleukin ..... 191  
Inverted terminal repeats (ITRs) ..... 86, 95, 96  
iRFP713.....172, 176, 177, 181  
Isoflurane .....5, 7, 8, 57, 75, 77, 78, 80, 110

**K**

Kinase ..... 23, 29, 30, 32, 33,  
 37–39, 120–123, 202, 233–245, 274  
 KNIME ..... 139, 141, 142, 144, 145, 148  
 Knockout ..... 263  
 KRAB domain ..... 160, 161

**L**

Laser ..... 6, 16, 55, 56, 60, 62–64,  
 67, 72, 75–78, 80, 107, 110, 133, 140, 142, 147,  
 171, 175, 177, 183, 184, 206, 207  
 Light-emitting diode (LED)  
 array ..... 190–196, 212  
 Light-oxygen-voltage (LOV)  
 AsLOV2 ..... 128  
 EL222 ..... 160, 161  
 J $\alpha$  helix ..... 114–116, 120, 123  
 VfAU1-LOV ..... 235, 244  
 Linker ..... 114, 116, 118, 120, 268, 275  
 Loopology ..... 118–123  
 LOVTRAP ..... 117, 118  
 Luciferase  
 gaussia ..... 203  
 luminopsin ..... 203  
 nanoluciferase ..... 203  
 Lysogeny broth (LB) ..... 220

**M**

Macaques ..... 102, 110  
 Macula ..... 101  
 MAP kinase (MAPK) ..... 23, 30, 32,  
 233, 242, 243, 245  
 mCherry ..... 15, 16, 54, 59, 61,  
 62, 64, 67, 130–132, 134, 135, 138, 157, 172,  
 176, 177, 179, 184, 185  
 4-Methoxy-7-nitroindolyl (MNI) ..... 25  
 Microscope/microscopy ..... v, 6–8, 11,  
 14–17, 35, 40, 55, 56, 60, 62, 65, 67, 76, 79–81,  
 103–106, 114, 129–131, 133, 134, 138–147,  
 157, 162, 163, 165–167, 171, 172, 175–177,  
 206, 210  
 Molecular dynamics ..... 120  
 Mouse ..... 1, 4, 7–9, 16, 37, 54,  
 55, 57–61, 63, 64, 66, 67, 71–81, 102, 116, 183,  
 274, 275  
 MS2 ..... 172, 176, 265, 267, 272  
*Myxococcus xanthus* ..... 235

**N**

Nanobodies ..... 28, 29, 36  
 Near-infrared (NIR) ..... 71, 171–187, 272  
*Neurog2* ..... 274

Neurons

hippocampal ..... 27, 39  
 Nitrocellulose ..... 5, 6, 8, 10, 12  
 Nuclear  
 export ..... 123, 124, 128  
 import ..... 123, 124, 128  
 localization signals ..... 123, 128, 172  
 Nuclease ..... 87, 261, 269

**O**

Opsin  
 channelrhodopsin ..... 27, 257  
 channelrhodopsin-2 (ChR2) ..... 4, 16,  
 17, 53, 256  
 chrimson ..... 3  
 chronos ..... 3  
 melanopsin ..... 27, 53  
 rhodopsin ..... 27  
 Optical fibers ..... 54, 64, 67, 71  
 Optogenetic stimulation ..... 1–17, 55,  
 60, 64, 68, 72  
 Organelle  
 endoplasmic reticulum (ER) ..... 40  
 endosome ..... 34, 36, 37  
 nucleus ..... 40  
 Oscillations ..... 30, 60, 67, 118, 203  
*Oscillatoria acuminata* ..... 30

**P**

Patch clamp ..... 1–18, 56, 63, 248  
 Petri dish ..... 5, 6, 8, 12, 15, 164, 192  
 pH ..... 5, 6, 9,  
 38, 55, 56, 66, 79, 87, 88, 146, 154, 156, 163,  
 164, 167, 184, 189, 192, 220–222, 227,  
 237–239, 250, 252  
 Phosphodiesterase ..... 202, 203  
 Phospholipase C-beta ..... 23  
 Photo-inhibition ..... 115, 121, 123  
 2-Photon excitation ..... 3  
 Phytochrome  
 phytochrome B (PhyB) ..... 32  
 PIF ..... 31  
 Plasmid ..... 86, 89, 90, 96,  
 133, 142, 153, 155, 156, 160, 162, 164, 167,  
 184, 192, 198, 218, 222, 236, 242, 244,  
 251–253, 274, 275  
 Polymerase chain reaction (PCR) ..... 86, 89, 90, 96  
 Power meter ..... 10, 54, 58,  
 206, 207, 237, 240, 244  
 Primates ..... 101, 102, 190  
 Promoter ..... 2, 4, 54, 86, 89, 90,  
 102, 115, 133, 152–155, 159, 160, 162, 190,  
 192, 196, 218, 242, 243, 263, 265, 272, 274

Protein

purification ..... 85, 218, 223, 224  
transport ..... 127–135

Protein kinase

myosin light chain kinase ..... 123  
protein kinase A (PKA) ..... 23, 202  
protein kinase C (PKC) ..... 23

Protospacer adjacent motif

(PAM) ..... 137, 261, 262

PUMA ..... 160–162, 165, 167, 169

**R**

Rac1 ..... 115, 116

Rapamycin ..... 120–122, 266

Rat ..... 204

Receptor

β<sub>2</sub>-adrenergic receptor (β<sub>2</sub>AR) ..... 29

cannabinoid ..... 25

dopamine ..... 28, 37

G protein-coupled receptor

(GPCR) ..... 22–25, 27, 29, 30,  
32, 36, 37, 40, 53, 201

metabotropic glutamate receptors

(mGluRs) ..... 26, 27

M3 muscarinic acetylcholine ..... 30

Mu-opioid ..... 40

muscarinic acetylcholine ..... 25

photoreceptors ..... 29

receptor tyrosine kinase (RTK) ..... 32, 234

Region of interest (ROI) ..... 62, 63, 79,

131–133, 178

Restriction site ..... 87, 89, 90, 96

Retina

retinal imaging ..... 105

retinitis pigmentosa ..... 102

RFP ..... 15, 139, 140,

142, 144–149, 268, 269

**S**

SDS-PAGE ..... 223, 224, 241, 242

Secreted placental alkaline phosphatase

(SEAP) ..... 192, 196, 198

Silver staining ..... 85, 87, 94, 98

Single guide RNA (sgRNA) ..... 265, 267,

268, 270–272, 274, 276, 277

Skull ..... 4, 8, 9, 57, 58, 66, 67, 76–78, 80

Split proteins ..... 122, 151

*Staphylococcus aureus* ..... 269

Stereotaxic apparatus ..... 54, 57, 76

*Streptococcus pyogenes* ..... 138, 262

Synapses ..... 12, 111, 248

*Synechocystis* sp. .... 235

**T**

Tag

SNAP ..... 26, 28, 34–36

CLIP ..... 28, 34–36

GFP (*see* Green fluorescent protein (GFP))

Halo ..... 34, 36

tdTomato ..... 15, 16

Telomere ..... 138, 139, 142,

144–149, 172, 176, 266

TetR ..... 172, 173, 183

*Thermus thermophilus* ..... 235

Transactivator

P65 ..... 263

VP64 ..... 263, 267

Transcription factor ..... 29, 37, 128,

151–154, 160, 198, 272, 274

Transduction ..... 2, 21, 24, 95, 97, 190

Transfection ..... 61–63, 67, 86,

90, 129, 130, 132–134, 139–143, 145, 146, 149,

153–156, 162, 165–167, 175, 176, 180, 181,

183, 195, 198, 204, 207, 208, 212, 234, 236,

237, 239, 241, 243, 244, 251, 253, 262, 274

Transgene ..... 86, 89, 95, 96,

102, 270, 272, 274

Tumor ..... 274

**U**

Ultracentrifugation ..... 90

UniRapR ..... 119, 121, 122

U2OS ..... 139, 141, 142, 144,

145, 172, 173, 176, 181, 266

Upconversion

upconversion nanoparticles

(UCNPs) ..... 72, 77, 274

UVR8 ..... 218, 219

**V**

*Vaucheria frigida* ..... 235

Vav2 ..... 121, 122

Vector ..... 2, 5, 13, 17, 54–56,

61, 62, 64, 67, 84–86, 89, 90, 95–98, 129, 130,

140, 142, 145, 146, 148, 153, 155, 157, 192,

209, 212, 243, 251, 256, 269

Ventral tegmental area (VTA) ..... 72, 73, 75–80

Vibratomes ..... 5, 6, 8, 12,

13, 55, 56, 59, 60, 79, 81

Virus ..... 9, 16, 57, 63,

64, 66, 67, 75, 80, 106, 111, 112, 269

Vision restoration ..... v

Vitrectomy ..... 103, 104, 106, 110, 111

Voltammetry ..... 73–75, 78–79

**W**

Western blotting..... 85

**X**

Xenografts..... 274

**Y**

YFP..... 15–17, 134, 172, 185

**Z**

Zdk..... 116–118, 123, 124

Zebrafish..... 116, 243, 265