

INDEX

A

- Adenylyl cyclase 151, 193, 204
- Antibodies
 primary 23, 24, 28, 30, 38, 46, 56, 58,
 175, 179, 186, 195–198, 201, 206, 209, 210, 230, 231
 secondary 23, 24, 28, 30, 38, 46, 56–58, 61,
 175, 180, 186, 194–197, 206, 209, 210, 230, 231, 233
- Arl13b 7, 9–11, 124, 132, 138, 141, 143,
 193, 207, 208, 210, 211
- ARL13b 18, 19, 23, 38,
 40, 41, 43, 45
- Autophagosomal 59
- Autophagosomes 54, 55, 57, 62–66
- Autophagy
 autophagy related protein 5 (ATG5) 55, 57
 chaperone-mediated 53
 lipidated form of microtubule-associated protein
 1A/1B-light chain 3 (LC3) 54
 macroautophagy 53
 microautophagy 53
 phosphatidylethanolamine (PE) 59
- Axonemal
 assembly 237–241
 length 237, 238, 240
 protein assembly 238
- Axoneme (Ax)
 central pair (microtubules) 226
 doublets (microtubules) 225, 226
 dynein 218
 nexin 218
 radial spokes 218

B

- Basal body (BB) 35, 36, 42, 69, 98,
 181, 182, 220–222, 225, 226, 238
- Behavior 88, 90, 149, 151–153,
 160, 162, 173, 207
- Brain
 ependymal cell 211, 212
 hippocampus 205, 206, 212, 213
 hypothalamus 204, 206, 212, 213
 neocortex 208
 neurons 203, 205, 206, 212
 nucleus accumbens 213

C

- Caenorhabditis elegans* (*C. elegans*)
 amphid channel cilia 108
 amphid channel neurons 108
 CEM (Cephalic male) neurons 108, 109,
 114–117, 119, 120
 male-specific dendrite 108
 neuronal sensory cilia 108–120
 phasmid cilia 115
 worm 109–114, 118, 120
- Calcium
 channels 166
 cytosolic 137
 genetically encoded calcium indicators
 (GECIs) 124, 134, 141
 intraciliary 134, 139, 141
 oscillations 128, 134–139, 141
 signaling 124, 138
 waves 137
- Cells
 kidney 194
 mouse embryo fibroblast (MEF) 54, 55, 194, 200
 stem 36, 246
 Tg737 *orpk* kidney epithelial cells (KECs) 55
- Centriole
 architecture 246
 distal appendages 35
 duplication 218
 elongation 218, 223
 evolution 246
 stability 218
 transition fibers 35
- Centrosome
 pericentrin-like protein (PLP) 224
 pericentriolar material (PCM) 218, 224
 reduction 218
- Chemosensation
 chemoreceptors 150, 151
 chemoresponse 149–166
 chemosensory cilia 149–166
- Chlamydomonas
 ciliary chimeras 92
C. reinhardtii 2, 69–81, 84–90, 94, 246, 247
 dikaryon complementation 94

Chlamydomonas (cont.)
 flagella 2, 69, 84, 89, 90, 246
 IFT mutants 84
 long-short cells 92
 long-zero cells 86, 91–92
 mating strains 86, 92
 spinning cells 91

Cilia
 immotile 124, 131–134, 141, 216, 226
 motile 18–20, 124, 130–134, 141, 143, 226
 primary 3, 5, 17, 18, 35, 36, 40, 41, 45, 55, 58, 59, 65, 141, 170–176, 178–181, 183, 184, 186–190, 193–203, 207, 213

Ciliary
 activity 251–252
 assembly 55, 237, 246–248, 250–253
 beat frequency 248, 252
 beating 150, 253
 binding sites 151
 chimeras 92
 detachment 238
 diameter 170
 dilation 222, 224, 225
 distal segment 222, 224, 225
 dynein arms 225, 226
 dynein motors 132, 237
 excision 237
 import 1–13
 inversin region 170
 kinesin 8
 length 54, 58, 61, 65, 66, 199, 237
 membrane 1, 35, 36, 65, 69, 132, 141, 150, 156, 163, 170, 194, 237
 metachronal synchrony 246
 pocket (CiPo) 35–50, 98, 170
 protein transport 84, 89, 93, 94
 proximal segment 222, 224, 225
 regeneration 93, 240
 rootlet 222
 tip 170, 238
 transition zone (TZ) 97, 109, 170, 222, 224, 225, 237
 waveform 248

Ciliary markers
 acetylated α tubulin 175, 181
 acetylated- α -tubulin (AcTub) 38
 adenylyl cyclase III (ACIII) 204
 ADP-ribosylation factor-like 13b (ARL13b) 38
 detyrosinated α tubulin 196

Ciliogenesis 27, 31, 32, 40, 53–62, 64–67, 120, 170, 218, 246

Ciliopathies
 heterotaxy 123
 primary ciliary dyskinesia (PCD) 132
 polycystic kidney disease (PKD) 115, 118, 119

Clathrin
 clathrin assembly lymphoid myeloid leukemia (CALM) 38, 44, 45, 47, 196
 coated pit (CCP) 43–45, 47–49, 200
 coated vesicle (CCV) 43, 45, 47–49, 200

Congenital heart disease (CHD) 123

Cryosection 207–209, 229

D

Deciliation 153, 164, 166, 238–241

Drosophila
 antennal/antenna segments 219, 220, 224
 auditory cilium 220
 behavior 216
 chordotonal neurons 216, 219, 220, 222, 224, 225
 chordotonal organs 218
 embryo 216, 223–225
 external sensory (ES) organs 216, 218, 219
 gonial cell 221, 225
 Johnston’s organs (Jos) 220, 222
 larvae 216, 223–225, 230
 leg 219, 221, 224, 229, 230
 maxillary palp 219, 224
 olfactory neurons 234
 primary cilia 225, 226
 proboscis 219, 224, 229
 scolopale 222
 sensory neurons 216, 218, 219, 224
 spermatid 218, 221, 223, 226
 spermatocyte 216, 221, 223, 225, 226
 spermatogenesis 221, 226
 stem cell 221, 225
 testes 216, 221, 223–225, 230–233
 thorax 219
 type-I sensory neurons 216, 224
 wing 219, 224, 229

Dynein

arms 216, 218, 223, 225, 226, 249
 cytoplasmic 70
 motile cilia 18–20, 124, 130–134, 141

E

E. coli 26, 31, 70–72, 74, 123, 124, 250

Electron microscopy (EM)
 cryo-electron microscopy 226
 scanning electron microscopy (SEM) 193–195, 198–200, 202, 252
 single particle 70
 transmission (TEM) 40–43, 228, 233

Electrophysiology
 calcium channels 166
 hyperpolarization 152
 TRP channels 115
 voltage gated channels 11

Embryonic node	124
Endocytosis	
clathrin	36
early endosome (EE)	41, 43, 45
transferrin	49
Endosomes	36, 41, 43, 45
F	
Flagella	
<i>Chlamydomonas</i>	18, 19, 69
mutants	94, 95
paralyzed	89
Flagellar	
amputation	91
elongation	31
growth	84, 88, 90–92
regeneration	91, 95
Fluorescence	83. <i>See also</i> imaging
autofluorescence	83, 94, 224, 233 (<i>see also</i> imaging)
fluorescent proteins (FP)	83, 87, 93 (<i>see also</i> Imaging)
green fluorescent protein (GFP)	4, 18, 19, 29, 38
immunofluorescence	18, 19, 22–23, 27–29, 39–40, 44–47, 49, 56, 88, 127, 174, 179–180, 186, 197, 204, 206, 209, 224
photoswitching	173
G	
Gene knockdown	
dsRNA	250
morpholinos	132
RNAi	246, 247, 249–252
Gene of interest (GOI)	86–88, 93, 94, 120
Glycosylphosphatidylinositol (GPI)-anchored proteins	150, 151, 163
Green fluorescent protein (GFP)	4, 18–20, 28, 29, 62, 67, 83, 84, 86–88, 91, 93, 212
Growth medium	22, 24, 26, 27, 31, 174, 178, 194, 197
H	
Heart	
congenital heart disease (CHD)	36
disease	36, 123
jogging	139
looping	124, 139
Heterotaxy (Htx)	123
I	
IFT-B core complex	69–81
Imaging	
correlated light–electron microscopy (CLEM)	193–202
deconvolution	47, 58, 62, 171, 188
differential interference contrast (DIC)	4, 5, 28, 47, 65, 69, 130–132, 140, 142, 143, 195, 247, 248, 251
diffraction limit	170, 171, 180
direct stochastic optical reconstruction microscopy (dSTORM)	170, 173–181, 183, 184, 187–189
electron microscopy	1, 36, 39, 175, 216, 222–224, 247, 249, 252
epifluorescence	2, 28, 41, 44, 45, 47, 58, 62, 63, 94
fluorescence recovery after photobleaching (FRAP)	2, 4–5, 7–11, 97–99, 101–103, 105, 115
fluorescent probe	2
fluorescent reporter	66, 119, 224
fluorochrome	194
fluorophore	13, 58, 83, 89, 132, 138, 141, 171–173, 176, 178, 179, 185
immunocytochemistry	55–59
immunofluorescence microscopy (IFM)	17, 19, 22–23, 27–29, 32, 39–40, 45–47, 49, 196, 200
immunofluorescence staining	47
immunostaining	65, 180, 220, 221, 224, 227, 229–233
kymogram	91–93
kymograph	86, 92, 108–120, 131, 133, 248, 252
light microscopy	88, 91, 155, 195, 225, 239, 251–253
live cell imaging	8, 11, 12, 36, 47–49, 173, 204
live imaging	43, 119, 126, 132, 141, 219, 224–227, 229, 253
phase contrast	239, 240
photoactivated localization microscopy (PALM), 170	173, 174, 176
photobleaching	4, 8, 9, 12, 13, 84, 94, 115, 119, 136, 172, 185, 187, 189, 190
phototoxicity	12, 13, 84, 136, 172
resolution	132, 170–176, 178–181, 183, 184, 186–190
stimulated emission depletion (STED)	170–176, 178–181, 183, 184, 186–190
streaming video	108, 111, 114–115, 117
super-resolution microscopy	226
3D image reconstruction	47
total internal reflection fluorescence (TIRF) microscopy	83, 84, 86, 88, 89, 94, 95
video	47, 108, 114, 115, 117, 120, 247, 248, 251
Insects	
<i>Drosophila</i>	215–218, 220, 221, 223–233
Intraflagellar transport (IFT)	
anterograde	70, 92, 115
cytoplasmic dynein-2	70
heterotrimeric kinesin 2	69, 119
IFT20	12, 55, 87
IFT22	70, 71, 76–77, 80
IFT25	71, 72, 76–77, 79, 80
IFT27	70, 71, 76–77, 79, 80

Intraflagellar transport (IFT) (cont.)

IFT46..... 71, 72, 76–77, 80, 196, 247
 IFT52..... 71, 72, 76–77, 80, 196, 247
 IFT70..... 71, 76–77, 80, 196, 247
 IFT74..... 71, 72, 76–77, 79, 80
 IFT81..... 71, 72, 76–77, 79, 80
 IFT88..... 11, 55, 59, 71, 72, 76–77, 79, 196, 247
 IFT-A..... 70, 170
 retrograde 54, 69, 70
 Tg737..... 194
 velocity..... 91, 92, 94

K

Kinesin

heterotrimeric 69, 119
 IFT 11
 KIF17 8, 9, 11, 119
 kinesin II 119
 kinesin-2..... 9, 69, 109, 117, 119
 kinesin-3..... 119
 KLP-6/KIF28 107
 OSM-3..... 109, 117

Kupffer's vesicle

kymogram/kymograph
C. elegans..... 108–120
 diffusion..... 91, 92
 IFT particle tracking..... 92
 Planeria..... 248, 252

L

LC3 55–56, 59–62, 66

Left-right (LR)

asymmetry 124, 139
 axis patterning 123
 development 123, 124
 extraembryonic fluid..... 124
 left-right organizer (LRO) 123–134, 136–143
 organ situs..... 124
 phenotypic defects 138, 139

M

Mammalian cells

human pluripotent embryonal carcinoma stem cell line
 (NT2) 36, 37, 39–41, 43–49
 human retinal pigment epithelial cell line (RPE1/
 hTERT-RPE) 3, 16–20, 22, 24–27,
 31, 32, 36, 37, 40, 42–49
 IFT20^{-/-} MEFs 55
 IFT88^{-/-} MEFs 55
 mouse embryonic fibroblasts (MEFs)..... 55
 neuropeptide Y-expressing hypothalamic neurons..... 204
 NIH 3T3 cells 3, 7, 9, 11
 Tg737orpk mouse embryonic fibroblasts..... 194
 Mechanosensation 219
 3-methyladenine (3-MA)..... 55, 57, 65

Microtubule

acetylated α tubulin (AcTub)..... 38, 40, 43, 44,
 47, 50, 193, 196, 200, 203
 central pair 218
 detyrosinated α tubulin..... 196
 doublet..... 9, 223, 226
 singlet 226
 tubulin 12, 90

Mouse

kidney 203
 MEF (mouse embryo fibroblast) 55
 Mucociliary interaction 247
 Mucus..... 246, 249, 253

N

Nematode

culture..... 112
 growth media..... 109–112, 119
 worm pick..... 110, 112

Neurons/neuronal cells

dendrite 108, 116, 119, 218, 220
 neuronal cilia 108, 203–212
 sensory cell..... 216, 224, 226, 227, 229–230

Nodal

Nodal pathway..... 124

Notch 134

O

Olfaction

olfactory bulb 208

Organelles

autophagosomes..... 53
 centrioles..... 35, 69, 98, 215, 223, 225
 cilia 1, 16, 35, 69, 123, 132,
 170, 215, 220, 225
 flagella 1, 16, 69
 Golgi 16
 lysosomes 53, 64
 nuclei 198
 lysosomes 62

P

Paramecium

attractants 150, 152, 154, 156, 160–163, 165
 binding assays 151, 152, 154, 159, 160, 164, 165
 cyclic AMP (cAMP) 150, 154, 159
 electrophysiology 149, 152–155, 160–161
 forward-swimming 150
 membrane channels 151
 repellants 150, 152, 154, 156, 161

Particle tracking

direction..... 108
 distance..... 117
 docking 91
 intraflagellar transport (IFT)..... 69, 70, 91, 92, 94

trajectories91
 unloading.....91
 pH shock..... 90, 91, 238, 240
 Phosphatidylethanolamine (PE)54
 Phosphatidylinositol 3-kinase (PI3K)55
 Photoreceptor
 cell 97–99, 101–103, 105
 connecting cilium (CC)..... 97, 98, 100
 inner segment (IS).....97, 98, 100, 101, 103
 outer segment (OS) 97–99, 101, 103
 phototransductive membranes.....97, 98
 retina.....97, 100, 101, 104, 105
 pH-shock86
 Planaria
 gliding.....246
 locomotion.....246
 neoblast.....246
 regeneration250
 Schmidtea mediterranea 246–248, 252
 ventral surface (ciliated)..... 246, 249, 251, 252
 Polycystin118, 119
 Polycystin 2 (Pkd2/PKD-2)118, 119, 124, 132, 134
 Protein
 assembly.....238
 GPI anchored 150, 151, 163
 green fluorescent.....18, 19, 29, 38, 44, 83,
 84, 86, 93, 108, 110, 115, 170
 synthesis238
 Protists
 Tetrahymena84

R

Regeneration
 ciliary 93, 237–241
 synchronous 90, 95, 238–240

S

Schmidtea mediterranea.....246, 248
 Signaling
 glutamate receptor152
 G-Protein Coupled Receptor (GPCR) 132, 213
 Hedgehog (Hh).....1, 246
 intraciliary calcium 123–134, 136–143
 Kisspeptin receptor 1 (KISS1R)207, 208
 Melanin-Concentrating Hormone Receptor 1
 (MCHR1)132, 204, 207, 208, 213
 Nodal signaling.....124
 Notch signaling134
 phosphatidylinositol 3-kinase (PI3K).....55
 polycystin-1 (Pkd1)118
 polycystin-1 homolog (LOV-1).....118
 receptor tyrosine kinase (RTK).....36
 rhodopsin..... 98, 99, 101, 103
 Smad2/343, 48
 Smoothed (SMO).....11, 132
 Somatostatin Receptor 3 (SSTR3)11, 132, 207, 211

Transforming Growth Factor beta-1 (TGFβ-1).....38,
 47–48
 Transforming Growth Factor β receptor
 (TGFβ-R)..... 38, 47–48
 Wingless/Int (Wnt)246
 Sperm 16, 211, 216, 218, 221, 224–226, 231
 Starvation medium 22, 27, 194, 197

T

T-maze 149–156, 161–163
 Transient receptor potential (TRP) channel
 PKD 2115
 Transition zone
 Y-link.....1, 170
 Transport
 IFT-independent.....216
 intraflagellar (IFT)11, 55, 69–81, 84,
 88–92, 94, 95, 108, 109, 119, 120, 170, 172, 210, 216,
 218, 224, 237, 247
 particle..... 69, 91, 94

V

Vectorial97
 Vectorial transport97
 Vision
 connecting cilium (CC) 97, 98, 100
 cornea 100, 104
 disk membranes.....98
 lens 100, 104
 opsin98
 optic nerve104
 photoreceptor 97–99, 101–103, 105
 retinal pigment epithelium (RPE)..... 98, 101
 rhodopsin..... 98, 99, 101, 103
 sensory neurons 97, 219, 224, 225, 227, 229–230
 vectorial transport.....97

X

Xenopus99, 124
 X-ray crystallography.....70

Y

Y-link.....1, 170

Z

Zebrafish
 cilia 123–144
 embryos 128, 133, 136, 138
 epiboly stage136
 Kupffer’s vesicle124
 left-right organizer (LRO) 123–134, 136–143
 LR asymmetry124
 somite stage 124, 127, 129, 131, 133, 136
 tail bud.....129, 134
 tailbud..... 126, 128, 136