

Index

- actin filament, 28, 125
- action potential, 37, 40, 47
- acyl-homoserine lactone (AHL), 44, 136, 157
- additive inverse Gaussian noise (AIGN) channel, 100, 118
- addressing, 63
- addressing molecule, 52, 122
- adenine, 28
- adenosine diphosphate (ADP), 27
- adenosine triphosphate (ATP), 27, 31, 44
- ADP, *see* adenosine diphosphate
- AHL, *see* acyl-homoserine lactone
- AIGN, *see* additive inverse Gaussian noise
- amino acid, 22
- ANN, *see* artificial neural network
- artificial neural network (ANN), 164
- aspartate transcarbamoylase (ATCase), 123
- ATCase, *see* aspartate transcarbamoylase
- ATP, *see* adenosine triphosphate
- autoinducer, 44
- autoinducing polypeptide (AIP), 44

- bacterial conjugation, 40, 45
- Belousov-Zhabotinsky (BZ) reaction, 162
- bio-nanomachine, 2, 21, 53, 92, 122, 123, 129, 133, 136
- BioBrick, 66
- BMI, *see* brain-machine interface
- bow-tie architecture, 66
- brain-machine interface (BMI), 12
- Brownian motion, 71–74
 - first arrival time, 80–82
 - with drift, 100
- BZ reaction, *see* Belousov-Zhabotinsky reaction

- Caenorhabditis elegans* (*C. elegans*), 46
- calcium-induced calcium release (CICR), 43, 143
- calcium ion (Ca^{2+}), 42
- calcium signaling, 40, 42
- calmodulin, 43
- calmodulin-dependent protein kinase II (CaM kinase II), 123
- cAMP, *see* cyclic AMP

- capacity, 111, 114–117
- carbon nanotube (CNT), 147
- cell, 34, 136
- cell-surface receptor, *see* receptor
- Chebyshev's inequality, 88
- chemotactic signaling, 39, 40
- chemotaxis, 40
- chromosome, 29
- CICR, *see* calcium-induced calcium release
- CNT, *see* carbon nanotube
- COat Protein (COP), 42
- codon, 31
- communications model, 98
- concentration, 86, 94
- congestion control, 65
- connexin, 143, 160
- COP, *see* COat Protein
- cross-layer architecture, 65
- cyclic AMP (cAMP), 164
- cytosine, 28
- cytoskeleton, 34
- cytosol, 34

- delay-selector channel, 102, 108
- deoxyribonucleic acid (DNA), 28, 129
 - base-pairing rule, 29
 - complementarity, 29
 - ligase, 132
 - nanotechnology, 129
 - transcription, 30
 - translation, 31
 - walker, 131
- detection, 104–106, 108
- Dictyostelium*, 164
- diffusion coefficient, 39, 56
- DNA, *see* deoxyribonucleic acid
- drug delivery, 13, 152
- dynamic instability, 28, 125
- dynein, 27, 39

- E. coli*, *see* *Escherichia coli*
- EGF, *see* epidermal growth factor
- embryonic stem cell (ES cell), 156

- encoding, 53, 56
 endocrine signaling, 37
 endoplasmic reticulum (ER), 34, 42, 143
 entropy, 110, 117
 conditional, 110
 differential, 110
 joint, 110
 enzyme, 23, 123
 epidermal growth factor (EGF), 40, 46
 error handling, 62, 130
 ER, *see* endoplasmic reticulum
 ES cell, *see* embryonic stem cell
Escherichia coli (*E. coli*), 34, 41, 130, 157
 eukaryote, 34
 excitable chemical system, 164
- flagellum, 34, 40
 flow control, 62
- gap junction channel, 37, 44, 143
 Gaussian distribution, 89
 Gaussian random process, 90
 gene, 30, 137
 genetic engineering, 137
 GFP, *see* green fluorescent protein
 Golgi apparatus, 34, 42
 G-protein, *see* guanine nucleotide-binding protein
 green fluorescent protein (GFP), 13, 137, 158
 GTP, *see* guanosine triphosphate
 guanine, 28
 guanine nucleotide-binding protein (G-protein), 27
 guanosine triphosphate (GTP), 31
 guide molecule, 52, 122, 125, 131, 135, 142
- Hamming code, 62
 Hill function, 26
 hormonal signaling, 40, 47
 hormone, 47
- IEEE P1906.1, 11, 66
 in-network processing, 65
 induced pluripotent stem cell (iPS cell), 156
 information molecule, 52, 122, 129, 136
 information theory, 109–120
 inositol 1,4,5-trisphosphate (IP₃), 39, 43, 143
 inter-symbol interference, 84
 interface molecule, 52, 122, 130, 134
 intracellular therapy, 14, 154
 inverse Gaussian distribution, 81, 100, 119
 ion channel, 27, 48
 IP₃, *see* inositol 1,4,5-trisphosphate
 iPS cell, *see* induced pluripotent stem cell
- kinesin, 27, 125, 160, 161
- Lévy distribution, 81, 113
 lab-on-a-chip (LOC), 11, 158
 layer, 59, 97
 link, 61–63
 network, 64–65
 physical, 60–61, 97
 upper, 65–66
 ligand, 26, 93
 lipid membrane, 31
 liposome, 33, 132, 153, 160
 LOC, *see* lab-on-a-chip
 LuxR/LuxI system, 44, 136, 157
 lysosome, 34
- macromolecule, 55
 MAP, *see* maximum *a posteriori* detection
 Markov chain, 74, 94
 Markov property, 74, 75, 77, 80, 99
 maximum likelihood (ML), 105, 106
 maximum *a posteriori* (MAP) detection, 104
 media access control, 62
 MEMS, *see* micro-electromechanical system
 messenger RNA (mRNA), 30, 138, 154
 Michaelis–Menten kinetics, 25
 micro total analysis system (μ TAS), 158
 micro-electromechanical system (MEMS), 11, 158
 microfluidics, 146, 158
 microtubule, 28, 79, 125, 160, 161
 MIMO, *see* multiple input and multiple output
 mitochondrion, 34
 ML, *see* maximum likelihood
 modulation, 60
 mole fraction, 86
 molecular automaton, 154
 molecular communication
 analytical examples, 83, 105, 107, 112
 applications, 11–15, 152–166
 characteristics, 54–58
 components, 48, 52–60, 122
 design and engineering, 122–147
 examples from biological systems, 38–49
 history, 6–11
 model, 2, 52, 71–77
 network architecture, 58–66
 process, 53–54
 simulation, 77–78
 molecular imaging, 13
 molecular motor, *see* motor protein
 molecular rail, 27
 Moore's law, 162
 morphogen signaling, 40, 46
 motor protein, 27, 78, 125
 mRNA, *see* messenger RNA
 multiple input and multiple output (MIMO), 57
 mutual information, 111, 117
 myosin, 27, 58, 125
 μ TAS, *see* micro total analysis system

- nanonetwork, 9
- nanotube-vesicle network, 135
- network formation, 64
- neuron, 47
- neuronal signaling, 40, 47
- neurotransmitter, 47
- NTP, *see* nucleoside triphosphate
- nucleic acid, 28
- nucleoside triphosphate (NTP), 31
- nucleotide, 28
- nucleus, 34
- nullcline, 140

- organelle, 34

- paracrine signaling, 37
- parameter estimation, 106
- peptide, 22
- phospholipase C (PLC), 43
- phosphorylation, 23
- Physarum polycephalum*, 165
- plasma membrane, 34
- plasmid, 45
- PLC, *see* phospholipase C
- probability of error, 105, 110, 115, 116
- prokaryote, 34
- promoter, 30, 138
- propagation, 37, 54, 61, 72
 - active mode, 37, 79
 - passive mode, 37
- protein, 22, 123
 - allostericity, 27
 - cooperativity, 26
 - domain, 22

- quorum sensing, 40, 44

- reaction diffusion computation, 162
- reaction-diffusion wave, 38, 164
- receptor, 26, 41, 43, 93
- restriction enzyme, 129, 132
- ribonucleic acid (RNA), 28
- ribosome, 31
- RNA, *see* ribonucleic acid
- RNA pol, *see* RNA polymerase
- RNA polymerase (RNA pol), 30, 137
- routing, 64

- second messenger, 36, 55
- signal transduction, 26
- single-stranded DNA (ssDNA), 127, 129, 154, 160
- soluble N-ethylmaleimide-sensitive factor
 - attachment protein receptors (SNARE), 42
- SNARE, *see* soluble N-ethylmaleimide-sensitive factor attachment protein receptors
- ssDNA, *see* single-stranded DNA
- stem cell, 156
- sum-product algorithm, 108
- synaptic signaling, 37
- synchronization, 63
- synthetic biology, 66, 138

- targeted drug delivery, *see* drug delivery
- TCP/IP, 59
- terminator, 31
- thymine, 28
- thyroid-stimulating hormone (TSH), 40, 47
- thyroxine, 47
- timing channel, 100, 116
- tissue engineering, 12, 156
- transfer RNA (tRNA), 31
- transport molecule, 52, 122, 125, 131, 144
- tRNA, *see* transfer RNA
- TSH, *see* thyroid-stimulating hormone
- TNT, *see* tunneling nanotube
- tunneling nanotube (TNT), 37

- unconventional computation, 15, 162
- uracil, 28
- uridine triphosphate (UTP), 31
- UTP, *see* uridine triphosphate

- vesicle, 31
 - budding, 33
 - fusion, 33
- vesicular trafficking, 39, 41
- Vibrio fischeri*, 136

- WI, *see* Wiener-Ideal model
- Wiener process, 72
 - multi-dimensional, 76
 - with drift, 75
- Wiener-Ideal (WI) model, 99, 102, 111, 113, 115, 116

- Z channel, 113