

# Index

Locators in *italic* refer to figures

- adaptation, 113–115
- adenosine triphosphate (ATP), 54
- agent metaphors, 14–15, 24
  - biomedicine, 161–163
  - causation assumptions, 26
  - genes/genomes, 28, 38–40
  - proteins, 63–66
- Alberts, Bruce, 55–57
- Allaby, Michael, 128
- alleles, 38, 110
- allostery, 65
- altruism, 97, 110
- analogical reasoning, xii, 5, 9, 24
  - Charles Darwin, 89
  - cognitive role, 13, 168
- analogies, positive/negative/neutral, 5, 38, 165–166
  - cells, 70, 72
  - gene editing, 149–150
  - genes/genomes, 42
  - natural selection, 95–96
  - niches, 123
  - organisms–machines, 61–62
  - race and gender, 86–87
  - Tree of Life, 102–104, 109
- animism, 14–15
- anthropomorphism, 15, 48, 169
- anti-science movement, 167
- apoptosis, 77–82
- atoms metaphor, cells, 67–68
- Awise, John, 9–10
- balance of nature, 117–118, 126–130
- Ball, Philip, xiv, 165, 166
- battle against cancer, 139–140
- Bernard, Claude, 71–72
- biochemistry, 21, 52–53, 72
- biomedicine, 139–141
  - agent metaphors, 161–163
  - cell reprogramming, 82, 140–141, 153–156
  - CRISPR, 145–152
  - genetic engineering, 141–143
  - genome editing, 143–145
  - rewiring cells, 156–161
- biotech industry, 73–75, 142, 147
- Black, Max, 4, 86
- blueprints, genes/genomes, 11, 21, 33–37, 42–43
- book of life, genome as, 11, 23, 45–47

- Boudry, Marten, 60–61  
 Boyd, Richard, 9, 40  
 building blocks, life, 42, 48–49, 67–68
- cancer  
   battle against, 139–140  
   cell sociology, 77, 81  
   genetic program bug, 155–156  
   T-cells, 156–158
- catachresis, 8–9
- categories, 14, 25–26  
   agent metaphors, 14–15  
   information metaphors, 20–23  
   machine metaphors, 16–19  
   natural object metaphors, 23–25
- causation assumptions, 26
- cell fate, 154, 155
- cell suicide, 77–82
- cells, 67–68  
   computer metaphor, 82  
   dead metaphor, 70–71  
   factory metaphor, 20, 54, 55–57, 68, 71–73  
   genetic engineering, 73–75  
   original metaphor, 68–70  
   programmed cell death, 77–82  
   protein machines, 54–58  
   race and gender, 84–87  
   reprogramming, 82, 140–141, 153–156  
   signals/communication, 12, 51, 62, 63–64, 156  
   society metaphor, 75–77, 81  
   stem cells, 83–84, 153
- cell-wide web, 82
- Charpentier, Emmanuelle, 144–145
- chromatin, 41–42
- circuits, cellular/genetic, 22, 51, 68, 82, 152, 156–161
- Clements, Frederic E. 76, 133
- climate change, 128
- code, genetic, 20–21, 32–33, 40–42
- cognitive role, metaphors, 7, 13, 24, 168
- Cohen, Leonard, 3, 4
- Collins, Francis, 46–47
- communication role, metaphors, 168
- competitiveness, 97
- computer metaphors (cell, genome), 21–22, 68, 82, 152, 153, 160–161
- conceptual metaphor theory, 5, 126–127
- cooperation, 97
- cooperativity (molecular), 65
- COVID-19, 53, 140
- Crick, Francis, 20, 31, 33, 40, 105
- CRISPR technology, 22–23, 47, 144–145, 155  
   agent metaphors, 162  
   molecular scissors, 22–23, 145–152, 146
- Cuddington, Kim, 126
- cut-and-paste, gene editing, 145
- cybernetics, 20, 37
- Darwin, Charles, 15, 25, 29–30, 88–90  
   balance of nature, 117–118  
   economy of nature, 119–120  
   natural selection, 92–96  
   Tree of Life, 83
- Dawkins, Richard, 62, 109–113
- de Lorenzo, Victor, 160
- dead metaphors, 38, 70–71, 165–166
- Dennett, Daniel, 15, 161–162
- Dewsbury, Bryan M. 11
- DNA; *see also* genes/genomes  
   code metaphor, 40–42, 153  
   double-helix, 20–21, 31  
   junk DNA, 40–41, 113  
   molecular structure, 27  
   replication, 56–57  
   selfish DNA, 112–113  
   selfish gene, 111

## 196 INDEX

- DNA (cont.)  
  template, 48–49
- Doolittle, W. Ford, 106–107, 109, 113,  
  135–136
- Doudna, Jennifer, 144–145,  
  146–147
- ecology, 117–119  
  balance of nature, 126–130  
  economy of nature, 119–120  
  Gaia, 133–138  
  niches, 121–125  
  origin of term, 120–121
- economy of nature, 118, 119–120
- ecosystem health, 129–133
- ecosystems, 117–118, 125–126
- eggs/sperm, 84–86
- Elton, Charles, 121
- embryology, 77–78, 90–91
- endosymbiotic theory, 106–107
- engineering metaphors  
  cells, 23, 51, 60–62, 156–158  
  genes/genomes, 22, 73–75,  
  140–143
- enzymes  
  digestion, 34  
  DNA replication, 56–57  
  gene editing, 151–152, 156–158  
  proteins, 35, 49–51  
  yeast, 52–53
- epigenetics, 41–42
- evolution, 62, 76–77, 88–90  
  adaptation, 113–115  
  Gaia, 136  
  junk DNA, 113  
  metaphor, 90–92, 115–116  
  molecular biology, 105–109  
  natural selection, 92–96  
  niches, 124–125  
  selfish gene/DNA, 109–113  
  survival of the fittest, 96–99
- Tree of Life, 99–105
- exons, 40–41
- factory metaphor  
  cells, 20, 54, 55–57, 68, 71–73  
  metaphorical/literal, 73–75
- find-and-replace, gene editing, 149–150
- fitness, 96–98; *see also* survival of the  
  fittest
- food chain, 121
- framing of issues by metaphor, 26,  
  80, 115
- functions  
  agent metaphors, 15, 65–66  
  biological, 24–25, 113–115  
  metaphors, 140–141, 150, 168
- Gaia, 130, 133–138
- Gamow, George, 20–21
- gene editing, 140–141, 143–152
- genes/genomes, 11, 26, 27–28; *see also*  
  DNA  
  blueprints and programs, 33–37  
  critical analysis, 38–47  
  early history, 28–31  
  horizontal gene transfer, 106–107,  
  144  
  human genome project, 45–47  
  information and codes, 31–33  
  protein synthesis, 48–49  
  selfish gene/DNA, 12, 109–113
- genetic code, 20–21, 32–33, 40–42
- genetic engineering, 22, 73–75, 140–143
- genetic fatalism, 44–45
- genetically modified organisms, 142
- Gilbert, Scott, 85
- glial cells, 86
- Goodsell, David, 57–58
- Gould, Stephen J., 113–115
- grind-and-find techniques,  
  biochemistry, 72

- Haeckel, Ernst, 76, 77–78, 83, 102–104  
 Haldane, J. B. S. 25  
 hardware; *see also* computer metaphors  
 health, control, 140  
 Hesse, Mary, 2, 5, 61–62, 150  
 heuristic role of metaphors, 7, 13, 168  
 Hoffman, Peter M. 59–60  
 Hooke, Robert, 68–69  
 horizontal gene transfer, 106–107, 144  
 hormones, 73  
 Hortle, Elinor, 148–149  
 human genome project, 45–47  
 Hutton, James, 133
- information  
   flow, 33, 163  
   genetics, 20–21, 31–33, 40  
   metaphors, 20–23, 24, 26, 28  
 inheritance, 27  
 insulin, biotech industry, 73  
 intelligent design theory, 23, 60–62, 169  
 intentional stance, 15  
 internet metaphor, 82  
 introns, 40–41
- Jacob, Francois, 21, 34–35, 62, 65  
 Johannsen, Wilhelm, 30  
 Johnson, Mark, 5–7, 126–127  
 junk DNA, 40–41, 113
- Kampourakis, Kostas, 45, 64–65, 86–87  
 Kay, Lily, 23, 46  
 Keller, Evelyn Fox, 21, 30, 37  
 Kricher, John, 127–128  
 Kueffer, Chistoff, 9–10  
 Kuhn, Thomas S. 9
- laboratory metaphor, cells, 71–73  
 lac-operon model, 35  
 Lakoff, George, 5–7, 126–127
- landscape metaphors, developmental/  
   epigenetic, 25–26, 154, 154  
 Larson, Brendon, 9–10, 126–127, 129–130, 149, 166  
 lateral evolution, 106–107  
 Lego blocks, amino acids, 42  
 lenses metaphor, 163  
 Levin, Michael, 161–162  
 Lewontin, Richard, 10, 16–19, 44–45, 113–115, 123–124, 166  
 linguistic perspectives, 8–9, 23–25  
 Linnaeus, Carl, 119–120  
 literal vs. metaphorical meanings, 12–13  
   factories, 73–75  
   sexism/racism, 86–87  
 lock-and-key model, 52–53, 85–86, 96  
 Lockshin, Richard, 78  
 Lovelock, James, 130, 133–138
- machine conception of organism, 59  
 machine metaphors, 16–19, 140–141  
   causation assumptions, 26  
   cells, 60–62  
   proteins, 58–60  
 malware analogy, CRISPR, 148–149  
 maps, 10, 24  
 Margulis, Lynn, 134–135  
 Martin, Emily, 84–86  
 Mayr, Ernst, 25  
 mechanisms, 16–19, 65–66  
 Mendel, Gregor, 29  
 messenger RNA, 33, 35, 40–41, 151–152  
 messengers (molecular), 51  
 metabolism, 71  
 meta-metaphors, 9–10  
 metaphors, categories; *see also* categories  
 metaphors, roles in science, 13, 164–165  
   definitions, 2–4  
   historical perspectives, metaphors, 1–2  
   meta-metaphors, 9–10  
   metaphorical/literal, 73–75, 87

## 198 INDEX

- metaphors, roles in science (cont.)  
 miscommunication, 12–13  
 misunderstandings, 168–170  
 problems caused, 165–167  
 promotional metaphors, 147  
 social and linguistic perspectives, 8–9  
 societal impacts, 10–11  
 theories of metaphor, 4–8
- miscommunication, 12–13
- misunderstandings, 168–170
- mitochondria, 54, 67, 80–81, 106–107
- molecular biology, 105–109, 139
- molecular scissors (CRISPR), 22–23,  
 145–152, 146
- molecular storm/weather/noise  
 metaphor, 43, 59
- molecular surgery/therapy, 143, 148,  
 149, 150; *see also* gene editing  
 mRNA, 151–152  
 stem cells, 83–84
- Monod, Jacques, 21, 34–35
- Morange, Michel, 149
- motor proteins, 51–52
- musical score metaphor, genome, 43
- natural selection, 15, 23, 24, 62  
 Charles Darwin, 89  
 evolution, 92–96  
 molecular biology, 163
- nature  
 balance, 117–118, 126–130  
 economy, 118, 119–120
- Nelkin, Dorothy, 11, 147
- Nerlich, Brigitte, 11, 167
- networks, cell signals, 64
- networks, evolution, 107–108
- niches, ecological, 118, 121–125  
 construction theory, 124–125,  
 136
- Nicholson, Daniel, 58, 59
- nucleotides, 31–32
- objectivity, 115, 118–119, 166, 168–169  
 vs. subjectivity, 169–170
- Pardee, Arthur, 34
- pathology, cellular, 76
- pathways (molecular), 63–64
- pedagogical role, metaphors, 7
- phenotypes, link with genes, 39–40
- Pigliucci, Massimo, 60–61, 62
- Pinto-Correia, Clara, 85
- polypeptides, 49, 54
- polysemy, 19
- programmed cell death, 77–82
- programs, genes/genomes, 23, 34, 37,  
 43–45
- promotional metaphors, 147, 150
- proteins, 48–52  
 agent metaphors, 63–66  
 intelligent design theory, 60–62  
 machine metaphors, 54–60  
 research history, 52–54
- racism, 86–87
- receptors (cells), 63–64
- recipe metaphor, genome, 43
- recombinant DNA, 141
- recruitment (cells), 64
- regulatory genes, 34
- reproduction, differential, 97–98
- reprogramming cells, 82, 140–141,  
 153–156
- rewiring cells, 82, 152, 156–161
- rhetorical role of metaphors, 7, 13
- ribosomes, 49, 54
- Ruse, Michael, 19, 89, 115
- SARS-CoV-2 virus, 53, 140
- Saunders, John W., Jr, 78–79
- scalpel metaphor, CRISPR/Cas9,  
 150, 164
- Schleiden, Matthias, 68

- Schwann, Theodor, 69–70, 71  
 selection; *see also* natural selection  
 selfish gene/DNA, 12, 109–113  
 sexism, 86–87  
 sexual reproduction, 84–86  
 signalling, cells, 12, 51, 62, 63–64  
 similes, 4, 28  
 social perspectives, metaphors, 8–9, 87  
 societal impacts, metaphors, 10–11  
 society metaphor, cells, 75–77  
 software; *see also* computer metaphors  
 spandrels, 113–115  
 speciation, 91–96  
 Spencer, Herbert, 76, 96  
 sperm/eggs, 84–86  
 spike proteins, 53  
 stem cells, 83–84, 153  
 Stepan, Nancy Leys, 86–87  
 stream conception of life/organism, 25  
 structural genes, 34  
 structural proteins, 52  
 struggle for existence, 93–94  
 subjectivity vs. objectivity, 169–170  
 Sullivan-Clarke, Andrea, 87  
 superorganisms, 133  
 survival of the fittest, 89, 96–99  
 sustainability, 129–130
- switch (molecular), 34–35, 51, 63–64
- Tansley, Arthur, 125–126  
 target metaphors (biomedicine), 150  
 Taylor, Cynthia, 11  
 T-cells, 156–158  
 team players (proteins), 63–66  
 technological role of metaphor, 13  
 technomorphism, 16, 160  
 teleology, 15, 24–25, 169  
 teleonomy, 25, 64  
 template, DNA, 48–49  
 theory constitutive metaphor, 9, 40, 150  
 Tree of Life, 25, 76–77, 83, 105  
     Charles Darwin, 89, 99–105  
     revisions, 105–109  
 tree stem, 83
- Urnov, Fyodor, 143, 151
- Venter, J. Craig, 23  
 Virchow, Rudolf, 71, 76
- Watson, James, 20, 31  
 Wiener, Norbert, 20
- X-ray crystallography, 53–54