

## Index

- A priori* reasoning, 152–153  
 Acetyl-CoA, 92  
 Achaete-scute gene complex, 166, 199, 219–220, 227  
 Acid bath experiment, 96, 98  
 Action potentials, 23  
   mechanism, 21–24, 38–39, 40, 47  
 Activities, 23, 29, 30, 31, 272  
 Adaptationism, 37  
 ADP (adenosine diphosphate), 93  
 Algorithms, 67  
 Allchin, Douglas, 145  
 Allelomorphs, 195  
 Analog model, 68  
 Analogical reasoning, 63, 84  
 Analogy, 78, 80, 82, 84, 86, 253  
 Analogy, argument from, 62  
 Analytic/synthetic distinction, 206  
 Anomalies, 67, 69, 83, 87, 124, 148  
 Antennapedia gene complex, 163, 172, 182, 218–219, 257  
 Antibodies, 120  
   formation, 300, 301, 303  
 Antireductionist consensus, 19, 41  
*Aplysia*, 184  
 Apriorism, 151  
*Arabidopsis thaliana*, 154, 183  
 Argument from error, 114, 117, 123, 152  
 Aristotle, 6, 229, 272  
 Artifacts  
   experimental, 16, 105–106, 114, 121, 152, 284, 287–294  
   in microscopy, 287  
   optical vs. preparation, 287  
   technological, 166, 170, 171, 174  
 Artificial intelligence, 8, 67  
 ATP (adenosine triphosphate), 93  
 ATP synthesis, 95, 97, 98, 116  
 ATPase, 94, 95, 105–106, 107, 110, 119, 121, 125, 139–140  
 Auxiliary assumptions, 9, 90  
 Axon, 43  
 Bacteriophage, 154, 158, 168, 176, 200, 211, 215  
 Bacteriorhodopsin, 42, 107–108, 110, 114, 115, 117  
 Bateson, William, 64, 83, 86, 162, 195, 197, 209  
*Bauplan*, 237  
 Bayesian confirmation theory, 10, 88–89, 108–113, 126  
 Bayes's theorem, 89, 109  
 Beadle, George W., 165  
 Beatty, John, 32, 34, 273  
 Bechtel, William, 4  
 Behavior, 42, 46–48, 176, 179, 185  
 Belitser, V.A., 93  
 Benzer, Seymour, 158, 200–201, 212  
*bicoid* gene, 244, 247  
*bicoid* protein gradient, 244, 245  
 Bifurcation, 139  
 Binomial distribution, 117  
 Biodiversity, 155  
 Bithorax gene complex, 162, 166, 218, 219, 257  
 Boltzmann, Ludwig, 188  
 Bootstrapping, 88, 302  
 Boyer, Herbert, 159  
 Boyer, Paul, 94  
 Breeder-reactor, 12, 165, 168  
 Brenner, Sydney, 159

## Index

- Bridge principles, 18, 19, 41, 47, 189  
 Bridges, Calvin B., 197  
 Burian, Richard M., 179
- Caenorhabditis elegans*, 12, 46–48, 154, 159,  
 176, 183, 185  
 Cancer research, 133, 141  
 Capacities, 31–32  
   complex systems, 7, 36, 49  
   experimental systems, 11, 132  
 Carrier, Martin, 275  
 Cartwright, Nancy, 31, 271  
 Castle, William E., 197, 285  
 Catalysis, 79, 84  
 Catalyst hypothesis, 75  
 Catalyst, 75, 76, 83  
 Catchall, 89, 109  
 Causal dispositions, 31, 44, 49  
 Causal inference, *see* inference, causal  
 Causal parity thesis, 243, 260–265  
   strong, 260, 263, 265  
   weak, 260, 262, 265  
 Causal powers, 34  
 Causal regularities, 33  
 Causal relevance, 81, 83  
 Causal role functions, 7, 37–40, 49, 255,  
 273  
 Causal theory of reference, *see* reference,  
   causal theory  
 Causation, 29, 261  
   theory of, 262, 265  
   and laws, 29  
 Causes, as inus-conditions, 261  
 Cell membrane, 21, 100, 233  
 Centrioles, 233, 263  
*Ceteris paribus* laws, 271  
 Chance, Britton, 96, 105, 143, 145  
 Chemical hypothesis, 93, 101, 102, 109, 110,  
 125, 137, 146  
 Chemical intermediate, *see* intermediate,  
   chemical  
 Chemical theory, *see* chemical hypothesis  
 Chemiosmotic hypothesis, 94–95, 96, 97, 99,  
 101–102, 109, 110, 137, 143, 145, 174  
   experimental tests, 97–105  
 Chemiosmotic theory, *see* chemiosmotic  
   hypothesis  
 Chemistry, organic, 77, 80–82, 85, 87  
 Chemotaxis, 46–48  
 Chloroplasts, 96  
 Chromosomal rearrangements, 158, 162, 169  
 Chromosomal walking, 161–163, 166, 167,  
 168, 172, 182, 215, 216  
 Chromosome hypothesis, 65, 68, 71  
 Cistron, 201, 203, 212, 214  
 Citric acid cycle, 73, 303, *see also* Krebs cycle  
 Classical genetics, *see* genetics, classical  
 Claude, Albert, 137  
 Cloning, molecular, 160, 166, 169, 174, 225  
 Co-construction of model organisms and  
   research problems, 12, 177  
 Co-construction of theory and experiment, 129  
 Cohen, Stanley, 159  
 Coherence condition, 39, 40, 49  
 Cohn, Melvin, 60  
 Colinearity  
   genetic and cytological maps, 157, 285–294  
   genetic maps and amino acid sequences, 202  
 Colony hybridization, 160, 164, 167  
 Common cause principle, 16, 282  
 Comparability, 13  
 Comparison of theories, 13  
 Complementation test, 198–199, 201, 212  
 Complementation unit, 212  
 Complementation, intragenic, 212, 217  
 Complex loci, 158, 199  
 Concept formation, 14  
 Concepts, functional, 42–43  
 Conceptual change, 13  
   logical empiricist model, 188–189  
   with constant reference, 190  
   with floating reference, 223–227  
 Confirmation  
   bootstrap account, 88, 302  
   hypothetico-deductive account, 88  
   Bayesian account, *see* Bayesian  
   confirmation theory  
 Consensus, 144–146  
 Conservatism, 111  
 Context of discovery, 1, 52–54, 82, 86, 128,  
 149  
 Context of discovery/context of justification  
   distinction, 52–54, 127, 150  
 Context of generation, 62  
 Context of justification, 52–54, 61, 62, 63, 82,  
 127, 149  
 Contingency, high-level, 32–33  
 Control experiments, 10, 116, 119–122, 134,  
 146  
 Conventions, methodological, 151  
 Coulomb force, 30  
 Coulomb's law, 31, 271

## Index

- Counterfactuals, 30, 259  
 Covering laws, 26  
 Craver, Carl, 21, 29, 85  
 Crick, Francis, 133, 135, 159, 277  
 Critical rationalism, 1, 127, 128  
 Critical test, 136  
 Crossing-over, 66–67, 84, 157, 158, 198, 213, 284  
 Crucial experiment, 107  
 Culp, Sylvia, 291  
 Cultural transmission, 238  
 Cultures, local, 11  
 Cummins, Robert, 38  
 Cytochrome oxidase, 106, 122, 125  
 Cytochromes, 92, 136
- Danielli, James, 136  
*Danio rerio*  
 Darwin, Charles, 14, 194  
 Data models, 124, 125, 126  
 de Robertis, Eddy, 164  
 Deduction, of repressor hypothesis, 58  
 Definitions, 13, 209  
 Determinism, 298–299  
   genetic, 230, 237, 264  
 Development, 15, 159, 230–247  
   “democratic” view, 231  
   and epigenetic inheritance, 234  
   and genetic program, 229, 258, *see also*  
     genetic program  
   and information, 248  
   and master control genes, 257  
   and the homeobox, 164  
   as goal-directed process, 254  
   genetic control, 162, 164, 186  
   in *C. elegans*, 154  
   in *Drosophila*, 243–247  
   molecular basis, 12, 159, 186  
   mosaic theory, 156  
   role of genes, *see* genes, role in development  
 Developmental systems theory, 15, 230–247  
 Diagrammatic representations, 69  
 Dinitrophenol, 98, 140  
 Disciplinary boundaries, 132, 133, 165  
 Discovery  
   as misnomer, 50, 51  
   context of, *see* context of discovery  
   logic of, *see* logic of discovery  
   scientific, 7, 9, 70, 81  
 Distribution, vs. causal regularity, 33  
 Diversity of life, 11, 155
- DNA (deoxyribonucleic acid)  
   double helix model, 148, 200  
   as genetic material, 148, 180  
   and intentionality, 253  
   as master molecule, 231, 257  
   primacy in inheritance, 236, 237, 242, 264  
   as research object, 148  
   role in development, 15, 230–247, 258–265  
   selfish, 167  
   semantic properties, 230  
   semi-conservative replication, 148, 159, 277  
   structure, 133, 148, 159, 200  
   as transforming principle, 148  
 DNA-RNA hybridization, 160  
 Dobzhansky, Theodosius, 158  
 Dominance, 49, 59  
 Double bluff theory, 60  
 Driesch, Hans, 156  
*Drosophila melanogaster*, 12–13, 65, 154, 156, 177–187, 234, 243–247  
   genes, 215–223  
   molecularization, 157–166, 169  
 Duhem, Pierre, 90  
 Duhem-Quine thesis, 9  
 Duhem’s problem, 9, 104–105, 124, 126  
 Dutch book, 89
- E. coli* (*Escherichia coli*), 12, 56, 133, 154, 156, 158, 160, 167, 168, 176, 200, 215  
 East, Edward M., 195  
 Ecology, 28  
 Economic notions, 172–173  
 Einstein, Albert, 52  
 Electron microscopy, 119, 141, 269, 288–291  
 Electrons, existence of, 279  
 Ellis, Brian, 34, 271  
 Empirical equivalence, 101, 126  
 Energy metabolism, 91, 93  
 Energy-linked functions, 94, 97, 101, 102  
 Enzyme induction, 56, 82, 83, 84, 86  
 Epigenetic inheritance, 230, 232, 233–235, 238, 263  
 Epistemic things, 132, 135, 141, 143, 147–148  
 Epistemology, 128, 129  
 Equilibrium potential, 31  
 Error probability, 10, 113, 115, 116, 117, 118, 126  
 Error, type I, 113  
   control, 119–126  
   repertoire, 152

## Index

- Error-statistical approach, 10, 113–118  
   informal, 117, 123, 126
- Essence, 45  
   unchanging, 225
- Essentialism, 225, 271
- Evidence, 88–91  
   crucial, 97, 103, 110, 115, 117, 145
- Evolution, 36–37, 40, 158
- Evolutionary contingency thesis, 6, 32–35, 49, 273
- Evolutionary descent, 180
- Evolutionary theory, 2–3, 7, 9, 28, 43, 45, 127
- Experimental cultures, 153
- Experimental systems perspective, 11, 136–153
- Experimental systems, 10, 121, 130–135, 154, 155  
   cognitive resources, 132  
   hybridization, 132, 141  
   intrinsic capacities, 132, 143, 145, 148  
   material resources, 132
- Experimentalist argument, 16, 278–281
- Experimentation  
   explorative, 128  
   as intervention, 129, 171  
   preparative, 174–176, 183, 187
- Explanation, 6, 24, 25  
   causal-mechanical account, 24, 26  
   deductive-nomological account, 25, 26  
   functional, 6–7, 35–41, 229, 255  
   pragmatics, 41  
   reductive, 229–231  
   structure, 24, 28
- Explanatory heteronomy, 20, 28–29, 32–33, 35, 42, 49
- Explanatory hiatus, 43
- Explanatory ideal, 27, 29
- Explorative experimentation, *see* experimentation, explorative
- Extrapolation from model organisms, 179, 182, 185
- Factors, Mendelian, 14, 194
- Fallacy, historical, 78
- Family resemblance, 204
- Feyerabend, Paul, 13, 127, 129, 189
- Final cause, 35
- Fine-structure map, 201, 202
- Fitness, 36, 39, 43, 49
- Force  
   electrostatic, 31  
   osmotic, 31
- Free-etching technique, 289
- Freeze-fracturing technique, 289
- Frege, Gottlob, 190
- Functional kinds, 272
- Functions, biological, 7, 49, 255  
   causal role, *see* causal role functions  
   etioloical, 7, 36–37, 49, 252
- fushi tarazu* gene, 163, 182, 218, 244
- Gap genes, 244, 246
- Gehring, Walter, 163, 172, 182, 216
- Gemmules, 14, 194, 209, 217
- Gene concept, 14, 188, 193, 204  
   classical, 203, 204, 211, 213, 217, 223, 226, 227, 228  
   history, 193–203  
   meaning, 204  
   molecular, 203, 214, 217, 226, 228, 259  
   Neo-classical, 203, 212, 228
- Gene expression, regulation of, 56
- Gene, classical theory of the, 8
- General relativity theory, 52, 276
- Generalized induction theory, 57, 83
- Genes  
   as difference makers, 204  
   as functional kinds, 272  
   as nucleotide sequences, 203  
   as theoretical entities, 269, 281  
   as units of function, 198–200, 201  
   as units of mutation, 199–200, 201  
   as units of recombination, 199–200, 201, 210  
   causal priority, 259–260, 265  
   causal role, 204  
   classical, 227  
   control regions, *see* regulatory regions  
   homeotic, *see* homeotic genes  
   linear order, 66  
   molecular, 227  
   regulatory, 202  
   regulatory regions, 203, 213, 214, 220, 227, 237, 245  
   role in development, 15, 232–243, 256–265  
   structural, 202, 213
- Genetic code, 32–33, 132–135, 180, 181
- Genetic engineering, 16, 160
- Genetic map, additivity, 284–285
- Genetic mapping, *see* maps, genetic

## Index

- Genetic program, 229–230, 252, 257–258, 262, 263
- Genetics, classical, 28, 43, 82–83, 86, 168 defined, 297
- Genome, human, 183
- Genomic DNA sequence, 154, 159 human, 183
- Genomic library, 160, 161, 182, 215, 223
- Genomics, 183
- Germ-line transformation, 167, 216
- Giant chromosome, *see* salivary gland chromosome
- Giere, Ronald N., 123
- Glycolysis, 92, 100, 109
- Glymour, Clark, 88
- Glynn Research Laboratories, 137
- Goldschmidt, Richard, 199
- Golgi apparatus, 288
- Golgi, C., 288
- Gradient  
   chemiosmotic, 94, 125  
   electrochemical, 31, 43  
   morphogen, *see* morphogen gradient
- Griffiths, Paul, 232–233
- Group translocation, 137
- Hacking, Ian, 16, 128, 278
- Halobacterium*, 105–106
- Hanson, Norwood Russell, 51
- Henseleit, Kurt, 74
- Heuristics, 9  
   problem-solving, 9, 67, 81, 82, 83, 85, 87
- High-energy intermediate, *see* intermediate, chemical
- Histones, and epigenetic inheritance, 234, 235, 236
- Hodgkin, A.L., 11
- Hogness, David, 160, 162, 172
- Holism, 18, 37
- Holmes, Frederic L., 9, 73
- Homeobox, 164, 167, 172, 182
- Homeotic genes, 237  
   cloning, 162–164
- Homeotic loci, 162
- Homeotic mutants, 162
- Homeotic selector genes, 244, 246, 254, 257
- Homo sapiens*, 156
- Hoyningen-Huene, Paul, 52
- Hudson, Robert, 291, 292
- Hull, David, 3
- Huxley, A.F., 21
- Hybrid techniques, 168–169
- Hybridization, *see* DNA-RNA hybridization
- Hypothetico-deductivism, *see* confirmation, hypothetico-deductive account
- Imprinting, genomic, 234, 236
- In situ*-hybridization, 161, 162, 163, 166, 168, 216
- In vitro*-system, 132, 142, 147
- Incommensurability, 13, 14, 189  
   thesis, 13
- Independent assortment, *see* law of independent assortment
- Induction  
   enumerative, 180  
   problem of, 179
- Inference to the best explanation, 16, 264, 274, 282, 283, 285–286
- Inference  
   causal, 81, 83, 85  
   inductive, 182, 185  
   phylogenetic, 181–182  
   scientific, 9, 89, 102, 127
- Information concept, 15  
   intentional (semantic), 241, 251–252  
   pragmatic, 241, 274
- Information theory, 135
- Information transfer, 135
- Information, genetic, 15, 135, 230, 232, 240–243, 255, 263, 273
- Inheritance, biological concept, 233, 237, 263
- Innovations, technological, 134, 141
- Instrumentalism, 266
- Intentionality, 14, 230, 240, 250, 263
- Intermediary metabolism, 76, 82, 83, 87, 136
- Intermediate, chemical, 93–94, 97, 98, 99, 101, 102, 108, 110, 113, 115, 125, 137, 140, 147
- Intervention, experimental, 129
- Introns, 202
- Inversions, chromosomal, 162, 163
- Ion channels, 47, *see also* voltage-gated channels, ligand-gated channels
- Jacob, François, 8, 56, 60, 131, 159, 202
- Jagendorf, André, 96
- Janssens, F.A., 66
- Johannsen, Wilhelm, 195
- Justification, context of, *see* context of justification

## Index

- Kant, Immanuel, 72, 268  
 Kaufman, Thomas, 163  
 Kay, Lily, 315  
 Keilin, David, 92, 136  
 Kekulé, F.A., 52  
 Kinds, natural, *see* natural kinds  
 Kitcher, Philip, 14, 192, 212, 227  
 Kohler, Robert, 12, 164, 186  
 Krebs cycle, 92, 94, 100, 142, *see also* citric acid cycle  
 Krebs, Hans, 9, 73–83, 85, 87, 92  
 Kripke, Saul, 13, 191  
 Kuhn, Thomas, 13, 80, 127, 129, 189, 266
- Laboratory setting, 149–153  
 Language, philosophy of, 13  
 Laudan, Larry, 101, 151  
 Law of independent assortment, 64, 67, 68, 210  
 Law of segregation, 64, 67, 83  
 Laws  
   biological, 6, 20, 49, 272  
   of nature, 6, 25, 29–35, 42, 49, 271–272  
   physico-chemical, 29, 32, 34  
   thermodynamical, 32  
   as relation between universals, 271  
   as causal dispositions, 271  
   and mechanisms, 29–32  
   and natural kinds, 272  
 Lehninger, Albert, 94  
 Lewis, Edward B., 162, 218  
 Ligand-gated channels, 21, 27  
 Likelihood, 109, 110, 111  
   as prior probability, 112  
 Linkage groups, 66  
 Linkage mapping, 66, 157, 175, 177, 202, 215, 284  
 Lipmann, Fritz, 93  
 Logic of discovery, 7–8, 71, *see also* logic of generation  
   generation  
 Logic of generation, 78, 82–85  
 Logic of justification, 78  
 Logic, deductive, 151  
 Logical empiricism, 1, 127, 128  
 Logical positivism, 18  
 Long-term potentiation, 184  
 Luria, Salvador, 211
- Machamer, Peter, 21, 29  
 Mackie, John, 29, 87  
 Mapping techniques, classical, 166
- Maps  
   cytological, 157, 167, 168, 175, 182, 215, 285–286  
   genetic, 12, 157, 165, 166, 168, 169, 172, 178, 187, 197, 284  
 Master control genes, 164, 257  
 Material culture, 4, 12, 13, 155, 170, 179  
 Matthaei, Heinrich, 133, 134, 159  
 Maynard Smith, John, 235, 251  
 Mayo, Deborah, 10, 89, 113, 126, 152  
 Mayr, Ernst, 3, 225  
 McLaughlin, Peter, 37  
 Meaning, 13  
 Mechanisms, 21, 23, 29–32, 47, 85  
   hierarchies, 184–185  
 Membrane potential, 21, 26  
 Membrane, *see also* cell membrane  
   artificial, 106  
   bacterial, 149, 289  
   functional asymmetry, 100  
   inheritance, 233  
   mitochondrial, 92, 94, 99, 100, 139  
   peroxisomal, 239  
   semipermeable, 138  
   structural and functional integrity, 140  
   transport physiology, 136  
 Mendel, Gregor, 188, 194  
 Mendel's laws, 32–33, 49, 64, 65, 69, 83, 209, 211, 213  
 Meselson, Matthew, 159  
 Mesosomes, 17, 288  
 Messenger RNA, 56, 135, 202  
 Meta-induction, pessimistic, 16  
 Meta-methodology, 151  
 Metaphors  
   economic, 155, 173  
   technological, 155, 170–173, 174  
   information, 230, 248, 262  
 Method of difference, 81, 120  
 Method, scientific, 1–2, 11, 90  
 Methodology, 144–153  
   statistical, 116, 126  
 Microsomes, 138  
 Middle-range theories, 24, 25  
 Mill, John Stuart, 81, 120  
 Millstein, Roberta, 300  
 Miracle argument, 16, 274–278, 282  
 Mitchell, Peter, 94–101, 136–137, 140, 143, 145, 277  
 Mitochondria, 77, 92, 138–139, 239  
   isolated, 97

## Index

- Model organisms, 11–13, 14, 155–187  
 as instruments, 13, 165, 170–171  
 as systems of production, 164–169  
 as technological artifacts, 166
- Models  
 interlevel, 24–25, 28  
 experimental, 124, 125, 126
- Molecularization of genetics, 12, 159
- Monod, Jaques, 8, 56, 60, 62, 159, 179, 202
- Moral economy, 166, 169
- Morgan, Thomas Hunt, 8, 65–67, 83, 84, 86, 154, 157, 178, 196–198, 284
- Morphogen gradient, 244, 246, 254, 264
- Mouse, 177, 179
- Moyle, Jennifer, 97, 137, 143
- Muller, Herman, 219, 285
- Multiple realization argument, 7, 42–49, 50, 51
- Multiple realization, 21, 42–49
- Mutations, random, 211
- NADH (Nicotinamide Adenine Dinucleotide), 92, 95
- Nagel, Ernest, 3, 18, 189
- Natural kinds, 6, 20, 33–35, 42–43, 44–45, 49, 193, 210  
 and laws, 272  
 fixed, 272  
 variable, 44
- Natural selection, 36, 37, 43, 252
- Naturalism, normative, 151–152
- Necessity, nomic, 30, 32–33
- Nernst equation, 26, 31–32
- Nerve signals, 20
- Nervous system, 6, 23, 25, 39, 40, 46, 184, 238  
*C. elegans*, 45–47  
 human, 185
- Neurons, 43, 47
- Neurospora*, 165, 172, 173
- Neurotransmitter, 21, 23
- New Experimentalism, 4, 90, 128–130
- Neyman-Pearson theory, 113, 117, 126
- Nirenberg, Marshall, 133, 134, 159
- Nola, Robert, 208
- Normal science, 80
- Norms  
 epistemic, 11, 143–148, 149–153  
 methodological, 11, 149, 150–153, 289
- Null hypothesis, 116, 117
- Oberheim, Eric, 318
- Observation statements, 127, 129
- Observation vs. experimentation distinction, 129
- Observation, theory-ladenness, *see* theory-ladenness
- Ochoa, Severo, 93
- Oenothera lamarckiana*, 156
- Oesterheld, D., 107
- One gene-one enzyme hypothesis, 165, 203
- Ontogeny, 3
- Operon model, 56, 202
- Organic chemistry, *see* chemistry, organic
- Ornithine, 74, 76, 79  
 effect, 75, 77, 83
- Orthologues, 183, 184, 185
- Osmosis, 32, 43
- Osmotic force, 30, 137
- Oxidative phosphorylation (ox-phos)  
 controversy, 9, 10, 11, 91–126, 136–143, 153
- Oxidative phosphorylation, 154, 277
- Painter, T.S., 285
- Pair-rule genes, 244, 246
- PaJaMo Experiment, 56–57, 60, 62, 83, 84, 151
- Pangenes, 195–203, 206, 207, 209
- Pangensis, 194, 209
- Pardee, Arthur, 56, 60
- Parsimony, 103, 105  
 argument from, 181
- Pax6* gene
- Peroxisomes, 239–240, 263
- Perrin, Jean, 281
- Phenomenal world, 267, 268
- Pheromones, 42, 43
- Phlogiston, 14, 94, 192, 225
- Phosphate bond energy, 93, 137
- Photosynthesis, 96
- Phylogeny, 3
- Physicalism, reductive, 42
- Plasmids, 159, 160
- Platonism  
 about scientific theories, 51  
 about scientific method, 152–153
- Polytene chromosomes, *see* salivary gland chromosomes
- Polyuridylic acid, 133, 134
- Popper, Karl, 1, 52
- Population biology, 34, 43
- Population genetics, 2
- Position effect, 199

## Index

- Positional information, 244, 247, 248–255, 264
- Predictions  
 by chemiosmotic hypothesis, 97, 99, 126  
 corresponding, 102, 126  
 of novel facts, 16, 99, 276–278  
 qualitative, 103, 277
- Presence-and-absence hypothesis, 197
- Priestley, Joseph, 192
- Primary hypotheses, 124, 125, 126
- Probability, 88–89  
 frequency interpretation, 115, 118  
 in informal arguments from error, 117–118  
 objective, 113, 282  
 posterior, 88  
 prior, 89, 107–108, 109, 110, 111, 112  
 subjective, 10, 113, 115
- Problem solving, 81  
 heuristics, *see* heuristics, problem-solving
- Program, developmental, 14
- Program, genetic, *see* genetic program
- Protein synthesis, 11, 56, 132–135, 156, 201, 236
- Proton gradient, 95, 98, 101, 105–106, 107, 113, 115, 125, 139
- Proton transport, 94, 95, 97, 98, 100, 102, 123
- Pseudoalleles, 200
- Punnett, R.C., 64
- Putnam, Hilary, 13, 42, 191
- Puzzle solving, 80
- Racker, Efraim, 96, 105–106, 125, 139–140, 142, 145, 152
- Rada, Roy, 71
- Rasmussen, Nicolas, 291
- Rationality  
 in the context of discovery, 53, 54–55, 86  
 scientific, 2
- Realism, scientific, *see* scientific realism
- Reasoning, generative, 81
- Recombinant DNA technology, 13, 159–160, 166, 167–169, 172, 176, 186, 215, 223
- Recombination, intragenic, 158, 199
- Reconstitution experiments, 106–108, 110, 114, 117, 119, 125, 141, 144, 145–146, 150–151
- Reduction  
 classical genetics to molecular biology, 3, 19, 20, 223  
 Nagel's account, 18–19, 42, 49  
 physical, 20  
 thermodynamics to statistical mechanics, 188–189
- Reductionism, 3, 6, 7–8, 15, 17, 18–21, 34, 42–50, 229–231, 255  
 as explanatory heteronomy, 28
- Reduplication hypothesis, 65
- Reference class, 113, 116, 117
- Reference failure, 207, 208
- Reference potential, 14, 192–193, 208, 209–215, 227
- Reference stability, 14
- Reference  
 causal theory, 13, 14  
 defined, 189  
 descriptive theory, 190, 192, 206–207  
 floating, 224–228
- Regulatory elements, 213
- Regulatory regions, *see* genes, regulatory regions
- Reichenbach, Hans, 52
- Relativism, 13
- Reliability, 147
- Reliable process reasoning, 292
- Replicators, 233, 235, 238–240, 247, 263
- Repressor hypothesis, 58, 59, 61, 62
- Repressor model, 56, 58, 59, 61, 62, 82, 84, 150–151
- Repressor, 56, 58, 59, 61, 202
- Reproducibility, 146
- Resources  
 cognitive, 132, 168  
 experimental, 169  
 material, 132, 168, 169, 172
- Respiration, 92, 95, 97, 98, 125, 136
- Respiratory chain, 92, 94, 95, 96, 100, 106, 108, 115, 121, 141
- Respiratory enzymes, *see* respiratory chain
- Resting potential, 21
- Restriction endonucleases, *see* restriction enzymes
- Restriction enzymes, 159, 168
- Revolution, molecular, 12, 159
- Revolutions, scientific, 224
- Rheinberger, Hans-Jörg, 10, 131–135
- Rhetorical strategies, 145
- Ribosomes, 138, 147
- Richardson, Robert, 4
- RNA, causal roles
- Robustness, 17, 291, 293
- Rosenberg, Alex, 266



*Index*

- Roux, Wilhelm, 156  
 Rubin, Gerald, 216  
*rudimentary* gene, 217  
 Ryter-Kellenberger technique, 289
- Saccaromyces cerevisiae*, 154, 176, 183  
 Salam, Abdus, 279  
 Salivary gland chromosomes, 161, 162, 166, 168, 177, 216, 285  
 Salmon, Wesley, 16, 24, 281  
 Sankey, Howard, 309  
 Sarkar, Sahotra, 20  
 Saunders, E.R., 64  
 Schaffner, Kenneth, 3, 4, 8, 24, 29, 53, 55, 82, 86, 112, 179  
 Scheffler, Israel, 189  
 Scientific realism, 15–16  
   about biological functions, 273  
   about information, 273  
   about laws, 271  
   about natural kinds, 272–273  
   about theories, 270  
   and independent determinations, 281–286, 292  
   and realism about space and time, 268–269  
   and theoretical entities, 269–270, 278  
   defined, 266  
   experimentalist argument, 278–281  
   miracle argument, 278–281  
 Segment polarity genes, 244  
 Segregation, *see* law of segregation  
 Self-reproduction, 37, 39, 41, 50  
 Semantic view of theories, 27  
 Sense, 190  
 Severity, 113, 117, 123  
 Simplicity, 181  
 Sirtes, Daniel, 298–299, 313  
 Slater, E.C., 93, 107, 136, 143, 145  
 Snypsas, 43  
 Social constructivism, 145, 267  
 Social interactions, 12  
 Species, 272  
 Stahl, Franklin W., 159  
 Stegmann, Ulrich, 315  
 Steinle, Friedrich, 129  
 Stent, Gunther, 257  
 Sterelny, Kim, 232–233  
 Stoeckenius, W., 107  
 Strategies, 9, 67–72, 82, 84  
 Sturtevant, A.H., 66, 197  
 Submitochondrial particles, 100, 119, 120, 139, 141, 142  
 Sutton-Boveri chromosome hypothesis, *see* chromosome hypothesis  
 Synaptic transmission, 27, 206  
 System of production, 12, 155, 164–169, 173  
 Szathmáry, Eörs, 235  
 Szilard, Leo, 60
- Tatum, Edward L., 165  
 Technical objects, 132  
 Teleology, 6  
 Teleosemantics, 251  
 Test  
   crucial, 9, 117, 125  
   experimental, 9, 174, 293–294  
   severe, 90, 113, 150, 293–294  
   statistical, 117  
 Theoretical entities, 14, 128, 147, 148, 269–270  
 Theoretical terms, 18, 19  
 Theories  
   as constructed, 51  
   middle-range, 24, 25  
   semantic view, 27  
   structure, 6, 24  
 Theory of evolution, *see* evolutionary theory  
 Theory reduction, 18, *see also* reduction, Nagel's account  
 Theory testing, 11, 17, 18–21, 144  
 Theory-ladenness of observation, 129  
 Thermodynamics, 18  
 Transcription factors, 245  
 Truth, concept of, 266  
 Tsybakova, E.T., 93  
 Turing, Alan, 314
- Ultracentrifugation, 138–139, 141, 152  
 Uncouplers of oxidative phosphorylation, 98, 101, 111, 120, 277  
 Underdetermination, of theory by the  
   evidence, 9, 91, 101–105, 126  
   logical, 101–102  
   logical vs. methodological, 92, 101  
   methodological, 102  
 Unit of function, 198–200, 201  
 Unit of mutation, 199–200, 201  
 Unit of recombination, 199–200, 201, 210  
 Unit-character, 195, 196–197, 207, 209, 228

*Index*

- Unity of science, 2, 123  
Universality of biological knowledge, 156  
Urea cycle, 9, 71, 77, 83, 87, 100, 154  
Uribe, Ernst, 96
- Values, epistemic, 94  
Van Fraassen, Bas, 266  
Variation, genetic, 224  
Vectors, gene-transfer, 184, 194  
Vienna Circle, 1, 2, 18  
Vitalism, 171  
Voltage-gated channels, 21, 22, 23,  
30  
Vries, Hugo de, 156, 194
- Warbur, Otto, 73  
Warburg apparatus, 73  
Waters, C. Kenneth, 3, 32–33, 213  
Watson, James, D., 133, 159, 277  
Weinberg, Steven, 279  
Whewell, William, 67  
*White eyes*, mutant, 159  
*white gene*, 65, 163, 166, 197, 216–217, 227  
Williams, G.C., 239  
Wolpert, Lewis, 248
- Yanofsky, Charles, 201
- Zamecnik, Paul, 133, 135, 142, 159