

Index

- abbreviations, xiii, xiv. *See also* genes, particular
- abdomen, xi, 49, 84, 141, 239
- sternites, 2, 30, 31, 56
- tergites, 2, 30–32, 56, 62, 122, 151
- Akam, Michael, 79, 84, 246, 247, 303
- anatomy, 2, 32
- antenna, 83, 199, 251
- bilateral symmetry, 191, 193, 209
- bristles, 5, 7, 30, 63
- encoding, xi, 37, 41, 45, 83, 101, 129, 191, 213, 239, 246, 254, 255, 297
- geometry, 31, 32, 99, 105, 128, 137, 189, 201, 211
- gradients, 30, 65, 99
- head, 41, 96, 199
- leg, 65, 99, 127, 131
- metameres, 76, 79, 84, 239, 243–247, 254
- mirror-symmetry planes, 62, 97, 99, 136, 167, 188, 198–201, 209
- periodicity, 77, 84, 136, 225, 303, 304
- sclerites, 2, 86, 89, 245, 299
- sexual dimorphism, 1, 56, 62–65, 72, 80
- thorax, 41, 193
- wing, 139, 153, 155, 159, 177
- antenna
- anatomy, 83, 199, 251
- axes. *See under* axes
- bipolar duality (vs. eye), 114, 169, 235, 302
- circuitry, genetic, 205, 249–252, 300
- compartments, 4, 199
- duplication vs. regeneration, 96, 169, 242
- evolution, 252
- fate map, 199
- gene expression patterns, 91, 193, 205, 251, 288–296, 302
- homeosis to leg, 80–85, 129, 249–252
- homology to leg, 83, 249, 251, 299
- Hox gene irrelevance, 249
- Hox gene misexpression in, 249, 251
- identity (vs. eye), 169
- identity (vs. leg), 83, 246, 249–254
- part of eye disc, xiii, 96, 169, 199, 302
- sensilla, 29, 191, 199, 246, 276
- topology (vs. leg), 83, 199, 299
- wiring of axons, 191
- apoptosis, 63, 77, 80, 92, 99, 100, 105, 118, 119, 123, 128, 135, 139, 157, 160, 227–229
- Aristotle, xi, xiii
- arthropods, 93, 99, 246, 300, 305
- Ashburner, Michael, xii
- asymmetry
- bilateral, 56, 67, 87
- bristle patterns, 31
- cellular, 7, 11, 24, 274, 304
- circuitry, 89, 107
- eye D/V, 203–211
- fluctuating, 21
- growth, 154
- growth potential, 118–119
- mitotic, 7, 11, 24
- ommatidia, 209–211
- symmetry-breaking, 47, 209–211, 304
- wing A/P, 188, 301
- wing D/V, 160, 164–167
- Auerbach, Charlotte, 76
- axes
- antenna D-V, 199
- antenna proximal-distal, 83, 251
- as reference lines, 84, 87, 89, 97, 101–105, 109, 151, 188, 203, 205
- body and limb, 30, 31, 155, 239
- bristle development, 30
- cell apical-basal, 24, 87, 124, 146, 273, 293, 304
- chordotonal, 27
- diffusion along, 65
- embryo A-P, 76, 79, 84, 87–90, 299
- embryo D-V, 87–91, 170, 239
- embryo left-right, 87
- eye A-P, 201, 208–211, 215, 227, 233–236, 305
- eye centrifugal, 229
- eye D-V, 202–211, 227, 233, 236, 299
- eye rhabdomeres, 199
- interdependence, 115
- larva, 205
- leg A-P, 89, 112
- leg A-P vs. wing A-P, 137
- leg disc centrifugal, 129, 131
- leg disc medial-lateral, 92
- leg disc upper(stalk)-lower, 92
- leg D-V, 61, 65, 67, 91, 97–99, 103, 109, 112, 115, 118, 119, 124–127, 132
- leg proximal-distal, 29, 30, 61, 67, 80, 83, 91, 115–118, 127–135, 148, 166, 201, 251, 300
- morphogen usage, 158, 249
- notum A-P, 30, 31, 37, 68
- optic lobe medial-lateral, 196
- positional information, 81, 87
- sternite A-P, 30
- tarsus D-V, 30, 62
- tergite A-P, 30
- tergite D-V, 30
- thorax A-P, 107, 132
- thorax D-V, 205
- wing A-P, 89, 137–156, 165, 167, 177, 301
- wing A-P vs. D-V, 158–161, 165
- wing centripetal, 125
- wing crossveins, 189
- wing D-V, 96, 136, 137, 146, 156–167, 170, 301
- wing proximal-distal, 132, 151, 159, 171
- Baker, Nicholas, 225
- Baker, William, 202
- Bang, Anne, 23
- Basler, Konrad, 151, 157
- Bateson, William, 99, 237
- Becker, Hans, 202
- Bender, Welcome, 305
- Benzer, Seymour, 202, 225
- Bernard, Francis, 201
- Blair, Seth, xii, 173, 301
- Bodenstein, Dietrich, xii, 76
- boundaries. *See also* compartment boundaries
- absence, 93, 95, 105, 123, 155, 203
- as axes, 84, 87, 89, 97, 101–105, 109, 188, 203, 205
- as chains of adhering cells, 151, 173
- as guidelines, 61–65, 163, 164
- cis*-enhancers for, 171, 245
- clonal, 67, 201, 202
- convergence/divergence (leg outgrowths), 100
- creation of, 78, 159–161, 173, 203–207, 236, 302

- boundaries (*contd.*)
 crossing of, 132, 136, 141, 148–154, 160, 173, 185, 201–204
 deformations, 151
 denoted by slash mark (vs. hyphen), xiii
 diffusion barriers, 125, 126, 143
 discontinuities, 93
 effects, 105, 115
 eye equator, 198–211, 296
 fuzzy, 128, 167, 193, 305
 gene dosage, 52, 69
 gene expression (ON/OFF), 89, 121, 131, 136, 153, 157–160, 165, 173, 177, 186, 191, 203, 207, 209, 234, 235, 299, 303
 gene expression at, 167, 171, 207, 209, 296
 gene expression, complementary, 78, 129, 131, 134, 135
 Hairy/Achaete, 63
 idiosyncrasies, 166
 insulating, 190
 intersections, 46, 90, 101, 137, 157, 234, 301
 kinks (natural), 112, 148
 $L_{2&7}$, 124
 leg dAC/vAC, 100, 109, 111, 117, 119, 132
 leg segment, 136
 maintenance, 148–153, 166, 173, 273
 male/female, 1–4, 52, 67
 metamere, 79
 midline, 59, 62, 63, 72, 77, 89, 99, 109, 113, 118, 131, 151, 164, 177, 262
 models, 100–111, 115, 122, 130, 163, 165, 302
 moving, 137, 229–234
 mutant/wild-type, 47, 52
 neural/non-neural, 151
 offsets, 97, 99, 109, 148, 224, 225
 parasegment, 78, 84, 90
 peripodial membrane, 139
 proneural clusters, 191
 rewiring of control, 171
 segment, 84
 sharpening, 78, 81, 84, 114, 184
 sharpness, 45, 167
 shifts, 89, 111, 119–123, 145, 188–190, 288
 smooth vs. ragged, 160, 173
 straddling of, 153, 164
 straightening of, 135, 148–153, 160, 173–174
 wing margin, 142, 147, 157, 159, 173, 245, 301
 Wingless/Engrailed, 78, 89, 90
 yellow/brown, 2
 zones, 111, 139, 302
bracts, 5, 7, 28–29, 61, 63, 67, 99
Bray, Sarah, 224
Brehme, Katherine, xii
Bridges, Calvin, xii, 37, 299
bristle patterns. *See also* bristles
 alignment, 67, 68
 ancestral, 62, 63, 135
 ancient, 31
 antineural gradients, 69
 antineural mask, 69
 antineural RNAs, 73
 antineural stripes, 59, 61, 62, 69, 75
 asymmetry, 56, 67
 basitarsus, 56, 62
 bristle density, 31, 49, 53–56, 73, 163, 187, 230
 bristle displacements, 37, 39, 43, 47, 49, 53, 68, 69, 163, 191, 229, 230
 brushes, 62
 cell-size dependence, 56, 68
 confluent lawns, 163, 229
 constant vs. variable, 31, 56, 67
 constellations, 32, 68
 CS vs. MS bristles, 67
 evolution, 31, 36, 62, 65, 69, 255
 fine-tuning, 50, 62–69, 75, 228
 functions, 31, 62, 65
 furry stripes, 59
 general problem, 31
 genetic control, 31–75, 190–194, 230, 278–284
 geometry, 31, 56, 59
 gradients, 62
 growth-dependence, 39, 50, 57, 63, 67
 heterochronic superposition, 56, 57, 67
 indeterminacy, 56, 59, 67, 68
 inhibitory fields, 50, 55–67, 71–75, 194, 195, 279
 isotropic, 32
 lattice, 32, 229, 230
 leg, 56–62, 65, 67
 macrochaetes, 190–194, 255
 macrochaetes vs. microchaetes, 31, 32, 56, 67, 68
 misalignment, 63
 modules, 62, 63
 mutant phenotypes, 278–284
 natural variation, 31, 37, 55, 56
 notum, 37, 41, 55–61, 65, 68, 190–194, 255
 other species, 67, 69, 255
 periodic, 67
 precision, 31, 56, 59–62, 65, 67, 69
 proneural clusters, 39, 41–75, 191–195, 225, 229
 proneural competence, 49, 59, 69, 72, 75
 proneural fields, 62, 68, 71, 72, 304
 proneural gradients, 164, 191
 proneural landscape, 69
 proneural machinery, 190
 proneural plateaus, 62
 proneural potential, 67, 68, 69
 proneural RNA motifs, 73
 proneural spots, 59, 62, 71
 proneural stripes, 59–63, 67–71, 75, 163, 280, 304
 proneural subclusters, 43, 46, 47, 50, 53, 69
 reconstitution, 67
 rotation, 63, 65, 67, 106
 rows, 31, 32, 56–62, 67, 68, 99
 rows, alignment of, 61, 65, 67
 rows, double (wing), 159, 189
 rows, extra, 61, 68, 80, 187
 rows, transverse (leg), 31, 62, 63, 65, 299
 rows, triple (wing), 148, 159, 164, 189
 scutellum, 49, 61
 sex comb, 32, 36, 62–67, 106, 246
 sex combs, extra, 80, 134, 135, 148, 248
 sex dimorphisms, 56, 62, 63, 65
 size-independence, 55, 62, 67
 spacing, 31, 50, 55–68, 99, 159, 187, 224, 225, 279
 sternites, 56
 sternopleura, 56, 86
 stochastic factors, 51, 72, 75, 201, 203, 299
 symmetry, 62
 tandem, 32, 65, 74
 tergites, 31, 56
 tufts, 23, 49, 52, 53, 59
 variety, 32
 vs. vein patterns, 175
 wing margin, 65, 67, 159
bristles. *See also* bristle patterns; sensory organ precursor (SOP)
 abdominal, 55
 anatomy, 5, 30, 63
 bracted vs. bractless, 7, 65, 67, 99, 134
 cell fate transformations, 7–28, 52, 271–275
 cell lineage, 4, 5, 21, 27, 30, 44
 central, 63
 chemosensory, 5, 27, 45, 57, 62, 67, 99
 CNS projections, 191
 deformed, 23, 48
 dendrite, 5, 23, 27
 determination of type, 27, 63, 72
 differentiation, 5, 11, 29, 36, 48
 elongation, 29
 evolution, 28, 29, 30
 extra, xiv, 20, 31, 45, 49–55, 59–62, 68–75, 80, 124, 164, 166, 194, 229, 278–284
 eye, 30, 57, 199, 209
 function, 5
 genetic control, 5–28, 271–277
 grooves, 23, 29, 298
 head, 31, 61
 homologies, 63
 inducers, 39, 50
 inhibitors, 53, 56
 leg, 5, 21, 27–31, 36, 56, 57, 61–67
 lengths, 29–31, 39, 41, 56, 62, 65, 73
 macrochaetes, xiii, 23, 31–62, 67–71, 75, 99, 190–195, 278–284
 macrochaetes vs. microchaetes, 20, 29–30, 57, 68, 191
 mechanosensory, 5, 27, 45, 57, 67, 99
 microchaetes, xiii, 31–62, 67–71, 191, 278–284
 migration, 63
 misoriented, 65
 missing, xiv, 20, 23, 31, 37, 45, 48–52, 71, 194, 278–284
 mutant phenotypes, 271–277
 notum, 29–31, 36, 39, 53–57, 62–68, 75
 number, 31, 67
 origin of glial cell, 5
 orphan, 63
 photosensitivity, 5
 pigmentation, 5, 23, 30, 63, 65, 99
 polarity, 29, 65, 67, 80, 205, 293
 sex comb, 7, 30, 36, 72, 149
 shaft-to-socket spectrum, 23
 shapes, 99
 size, 27, 29–30, 68
 sternites, 30
 sternopleura, 55, 56
 tergites, 30, 48, 65, 68
 thoracic, 4, 30
 timing of determination, 27, 30, 63, 68, 72
 timing of differentiation, 29, 39, 57, 67, 92
 timing of radioinsensitivity, 39
 transformation to sensilla, 28
 types (MS vs. CS), 5, 27, 65, 67, 99, 159
 vibrissae (head), 299
 vs. photoreceptors, 225
 vs. scales (lepidopteran), 29, 47, 61, 65, 67
 vs. sensilla, 27–28

- wing blade (ectopic), 49, 61
- wing margin, 5, 18, 27, 31, 48, 56, 143, 159–167, 189, 272
- Britten, Roy, 244
- Brody, Thomas, xiii
- Bryant, Peter, xii, 33, 80, 83, 93, 94, 139, 155
- Bryant, Susan, 93
- Cadigan, Kenneth, 158
- Cagan, Ross, 212, 217, 227
- Campbell, Gerard, 115
- Carroll, Sean, 41
- Castelli-Gair, James, 246, 247
- Cavodeassi, Florencia, 203
- cell adhesion, 65, 81, 87, 90, 92, 107, 132–136, 148–153, 160, 161, 173–177, 193, 204, 223, 257–261, 274, 281, 297
- cell affinities, 87, 90, 107, 132, 148–153, 160, 173, 174, 193, 204
- cell behaviors, 63, 85, 93, 96, 107, 122, 123, 132, 153, 190, 203, 235, 252
- cell competition, 105, 153
- cell components
 - cytoskeleton, 11, 257, 295
 - lysosomes, 27
 - microfilaments, 11, 29, 125
 - microtubules, 15, 109, 125
 - microvilli, 9, 87, 109, 179, 199
 - nuclear matrix, 249
 - nuts and bolts, 263
 - recycling, 300
 - rhabdomeres, 197, 199, 223, 224
 - ribosomes, 29
- cell cortex, 7, 9, 11, 15, 24, 179, 273, 274
- cell cycle. *See under* mitosis
- cell death, 63, 80, 87, 89, 95–97, 100, 113, 119, 135, 156, 174, 227–228, 299
- cell instructions, 4, 5, 9, 18, 20, 93, 99, 101, 115, 173, 205, 215, 216, 217, 228, 254, 255. *See also* pattern formation: rules
- cell jostling, 90, 91, 111, 149, 151, 173
- cell junctions, 20, 72, 92
 - adherens, 11, 75, 179, 180, 263, 294
 - making and breaking, 201, 304
- cell lineage, 1–4. *See also* compartment boundaries
 - adult vs. larva, 86
 - bracts, 5, 7, 28, 61, 63
 - bristles, 4, 5, 27, 30, 44
 - clonal analysis, 1–4, 86, 91, 99, 123, 201, 202
 - clone fragmentation, 91
 - clone fusions, 153
 - clone outlines, 3, 39, 67, 91, 201
 - clone overlaps, 91
 - clone roundness vs. raggedness, 132, 149–153, 160, 190, 201, 203
 - clone shapes, 133, 151, 153
 - compartments, 4, 44, 63, 85, 89, 99, 103, 104, 146, 150, 243, 245
 - compartments, function of, 87, 107, 148
 - compartments, regeneration of, 121
 - fluid vs. stereotyped, 3, 5, 7, 90, 91, 111, 149, 151, 173
 - heart, 4, 9
 - indeterminate, 3, 4, 85, 86, 91, 111, 123, 136, 149, 202, 212, 252
 - Minute* technique, 4, 91, 202
 - mixing, 105
 - muscle, 4, 9
 - nervous system, 4, 11
 - Proximity-vs. -Pedigree Rule, 4
 - sensilla, 1, 4
 - sex comb, 63
 - sibling rivalry, 9, 10
 - sternopleura, 86
 - strategies, 1
 - tracing, 3, 90
- cell migration, 86, 91, 99, 258
- cell movements, 61–67, 86–91, 131, 148–153, 177, 211, 230
- cell packing, 53, 55, 122, 134, 149, 174, 208, 233, 304
- cell polarity, 24, 29, 65, 67, 79, 80, 87, 131–136, 205, 211, 293, 304
- cell psychology
 - amnesia, 85, 249
 - antisocial behavior, 153
 - delirium, 107
 - how cells think, xii, 11, 83, 99, 111, 114, 124, 134, 136, 138, 143, 149, 154, 189, 190
 - memory, 10, 65, 81–84, 143, 158, 211, 239, 248, 251
 - myopia, 93, 94, 173
 - not goal-oriented, 255, 300
 - obedience to rules, 300. *See also* rules
 - schizophrenia, 65, 107
 - sibling rivalry, 9, 10
 - sociability vs. introspection, 1–4, 85, 299
 - suicidal tendencies, 228
 - what cells know, xii, 83, 85, 158, 244, 249, 254, 255
- cell rearrangements, 63–67, 89–91, 139, 174, 193, 209, 211, 304
- cell recruitment, 29, 30, 87, 208, 212–220, 224, 227–229
- cell shapes, 87, 99, 122, 124, 135, 151, 215, 233, 272, 273, 305
- cell signaling, 1–4, 50, 72. *See also* circuitry; signaling pathways
 - amplification, 13, 47, 188, 209, 211, 286, 300
 - amplitude, 53, 74, 103, 215
 - amplitude effects, 113, 154
 - amplitude modulation, 145, 303
 - analog vs. digital responses, 182
 - anisotropic, 37, 59, 65, 75
 - apical, 44
 - as evocation, 304
 - attenuation, 27, 134, 189, 264
 - attenuation, signal-dependent, 147, 182
 - autocrine, 52, 151, 167, 188
 - community effect, 85
 - competence to respond, 29, 35, 39, 43, 45, 109, 111, 145, 148, 153, 155, 164, 175, 215, 304, 305
 - contact-limited, 139, 145, 153, 157, 185, 285, 293
 - contact-mediated, 47, 53, 72, 93, 103, 135, 164, 165, 212, 215
 - context-dependent, 217
 - deafness, enforced, 35, 107, 150–153, 173, 229, 231, 235
 - deafness, natural, 55, 61, 107, 113, 117, 121, 145, 148, 150, 163–167, 183, 187, 188, 207, 209, 227, 295
 - default states, 11, 59, 85, 169, 216, 227
 - diffusion-mediated, 39, 46–49, 52–55, 72, 75, 80–85, 98, 101, 105, 118, 123–126, 133, 137–141, 167, 169, 182, 183, 203–209
 - direct vs. signal relay, 139, 141, 156, 167, 186, 215
 - duration, 182, 303
 - ecdysone, 11, 217, 229
 - endocrine, 92, 217
 - endocytosis, 53
 - gating into pathways, 10
 - hijacking by heritable determinant, 10
 - information content, 216, 217
 - intercellular negotiation, 94, 95
 - juxtacrine, 180, 212, 224, 304
 - ligand-independent, 182
 - mitosis-dependent, 217
 - mufflers, 134
 - muteness, enforced, 107, 153, 209
 - muteness, natural, 103, 107, 145, 148, 163–166, 183, 187, 207
 - need for mitotic quiescence, 44, 234, 304
 - one-bit (Stop! or Go!) signals, 215–218, 304
 - paracrine, 92, 125, 133, 166, 167, 231, 295
 - perception modulation, 125, 134, 143, 147, 158, 188–190, 286, 291
 - PI coordinates, 93, 99, 103
 - potentiation, 166, 207
 - primers vs. boosters, 216
 - qualitative vs. quantitative, 35, 83, 179
 - rate, 9, 181, 287
 - rectification, 147
 - resetting, 179, 182
 - rheostat vs. solenoid mode, 182, 303
 - second messengers, 141
 - sensitivity of reception, 230, 303
 - signal-to-noise ratio, 81, 124, 211, 228, 304
 - signal-to-receiver ratio, 60, 167, 286, 303
 - specificity, 179
 - strategies, xii, 1, 9
 - subthreshold, 36, 47, 68, 69, 117, 134, 174
 - transcytosis, 27, 124, 146, 167
 - trans*-ingestion of receptor, 175
- cell size, 29–30, 55–57, 65, 67, 92
- cell sorting, 90, 134, 148–151
- cell states. *See also* circuitry
 - affinities, 132, 148–153. *See also* cell affinities
 - as singularities, 158
 - automatic sequence of, 215, 229
 - axon projections, 55, 191
 - Boolean, 7–12, 18–23, 84–85
 - border vs. non-border, 149–153, 173, 205
 - cellular automata, 235
 - compartmental, 85, 89, 107, 145, 148–153, 158–163, 167, 173, 188, 202–208, 248
 - competence, 148, 217
 - created at interfaces, 87, 89, 107, 131–134, 142, 145, 153–155, 159, 160, 164, 177, 208–211, 234, 302, 303
 - default. *See under* circuitry
 - dependent vs. independent, 89, 90, 117
 - determined vs. specified, 81, 90, 173, 247–249
 - differentiated, 81, 87, 224
 - eye vs. antenna, 169
 - firm vs. transitory biases, 90, 173, 218, 248, 252
 - heritable vs. not heritable, 89, 90, 132, 143, 246–252
 - implementation by gene hierarchies, 149, 174, 177, 303
 - inherited by discs from embryo, 107, 164
 - intrinsic vs. extrinsic, 1–4, 9, 90–91, 124, 143, 149, 217

cell states (<i>contd.</i>)	169, 175, 179–182, 188, 234, 273, 275, 281–284, 292, 295, 303	in parallel vs. in series, 9, 44, 148, 161, 164, 181, 183, 291
leg dAC vs. vAC, 111, 113	antagonism vs. cooperation, 117	indeterminacy, 56
leg proximal vs. distal, 134	antagonism, self-evoked, 161	installation, 161
proneural, 75. <i>See also</i> under bristle patterns	antenna, 205, 249	limiting factors, xiii, 11, 12, 21–25, 29, 38, 60, 69, 72, 92, 113, 160, 182
quadrants in wing pouch, 158	antenna vs. leg, 249–252, 300	modules, 72, 179, 205, 208, 209, 305
qualitative vs. quantitative, 29–30, 139, 150, 246, 301	asymmetric, 107, 118–119, 164–167, 203–211	mutual activation, 44, 48, 90, 91, 133, 171
quantitative shifts in, 134, 135, 143, 147, 154–156, 189, 190	auto-activation, 47–51, 72, 91, 107, 171, 219	mutual exclusivity, 114
Ras-dependent diversity, 179	autocatalysis, 47, 50, 51, 69, 72	mutual repression, 50, 56, 77, 134
specified vs. determined, 90, 111	auto-repression, 18, 107, 132	neural networks, xiii, 255
spectrum within eye MF, 205	biasing, 10, 45, 47, 52, 72, 90, 109, 132, 164, 174, 191, 207–211, 216, 218, 227, 229, 248–252, 304	noise, 17, 21, 51, 228
switching, 7–12, 18–23, 52, 84–85, 101, 123, 132, 150, 182, 216–219, 223, 229, 242, 254, 261	biasing by Fringe, 164–167, 203–208	ON-then-OFF switching, 48, 91, 184
switching, fast vs. slow, 287	bipolar duality, 114, 167–173, 302	oogenesis, 170, 179, 181, 289
vein identities, various, 154–157	bistable seesaws, 25, 47, 106, 114–118, 170, 209, 299, 302	optimization, 79
vein vs. intervein, 141, 182, 187, 188, 259, 261, 303	branched control, xiv, 51, 161, 165	orchestration, xii, 79, 133
wing vs. hinge, 139, 158, 172, 301, 302	buffering, 21, 71, 73, 291	overreaction, 63
wing vs. notum, 169, 171–173	canalization, 73, 174	overrides, 10, 91, 107, 119, 128, 133, 137, 145, 164, 171, 190, 193, 246, 248
cell types	casades, xiv, 11, 20, 92, 139, 144, 174, 179, 199, 211–218, 224, 244, 249, 265, 297	physiological range, 50, 125, 132, 144, 151, 253
discrete nature of, 72, 246, 299	cell shaping, 23	plasticity, 91
encoding of, 10, 213, 243, 246, 254	circuit breakers, 137, 145	positive vs. negative control, 69, 79
immiscible, 90, 107, 132–134, 148, 150	clocks, circadian, 5, 263	precision, 45, 46, 73, 81, 211, 304, 305
iteration, 217	competition, 9, 10, 21, 23, 46–53, 59, 68, 161, 209, 211, 227, 229	priming, 48
laser ablation, 217	damping, 21, 47, 69, 72, 134, 163–167, 182, 235, 292, 304	protein-level, 72, 161, 263
neural vs. non-neural, 20, 216, 218, 224	default states, 7, 11, 47, 59, 65, 85, 148, 167–173, 197, 216, 227, 228, 251, 299	quantitative-to-qualitative, 81
ommatidium, 208–209, 223	design flaws, 228	quirks, 85, 123, 132, 133, 161, 182, 235
photoreceptors, 196, 197, 223, 253. <i>See also</i> photoreceptors	design principles, cell level, 73, 270, 304	rate control, 30, 68, 72, 73, 208, 229, 234
sequential emergence, 216	design principles, gene level, 19, 20, 73, 79, 91, 129, 142, 145, 148, 161, 173, 182, 207, 248, 270, 299	reconfiguration, 255
signaler vs. receiver, 107, 145, 148, 163–166, 183, 187, 207	design principles, protein level, 71–73, 79, 161, 163, 260, 263, 270, 300, 303	rectifiers, 147
squamous, 87, 122	design principles, tissue level, 57, 59, 62–67, 73, 87, 89, 107, 131–134, 142, 145, 153, 158–164, 177, 199, 228, 234, 235, 270, 302–305	rewiring, 63, 171, 245, 255
vein vs. intervein, 174–175	devices, various, 270	rheostats vs. switches, 30, 156, 182, 303
cells, cultured, 50, 61, 92, 217, 288, 303	discs vs. embryo, 86, 109, 113	robustness, 21, 73, 79, 81, 91, 98, 106, 136, 145, 174, 299, 304
Child, George, 39	dorsal discs vs. ventral discs, 171	safety switches, 145
circuit diagrams	driving factors, 25	saturation, 53, 72, 160, 167
for bristle cell fates, 7, 25, 27	dual control, 79, 92, 124, 183, 234, 254, 301	scalar vs. vector, 72, 81, 209, 211
for bristle patterning, 35, 41, 43, 47, 71, 75, 193	effective range, 69, 72, 73, 107, 119, 161, 209, 218, 304	segmentation genes, 78, 79
for compartments, 89, 111, 142, 145, 163, 205, 207	evolution, xi, 10, 31, 36, 63, 69, 72, 77, 136, 158, 173, 186, 223, 239, 244–247, 255, 262, 288, 299, 302, 305	sensing of amplitude, 147
for disc identity, 169, 239, 251	evolutionary relics, 36, 174	sensing of cell number, 145
for disc initiation, 89	feedback loops, xiv, 248, 252, 299, 300, 302	sensing of concentration, 81, 83, 158, 209, 211
for embryo segmentation, 78	feedback loops, negative, 164, 248, 291–295, 303	sensing of polarity, 81, 131, 136, 209–211, 293
for gene regulation, 17, 19, 41, 43, 47, 71, 75, 78, 111, 112, 117, 121, 127, 131, 141, 142, 145, 163, 169, 172, 177, 193, 205, 207, 211, 233, 239, 251	feedback loops, positive, 47–53, 72, 73, 79, 89, 121, 209, 211, 234, 248	sensing of position, 81, 83, 142, 158, 177, 211, 212, 251
for leg segmentation, 127, 131	fidelity, 10, 21, 72, 136, 209, 304	sensing of size, 81, 124
for photoreceptor cell fates, 233	fine-tuning, 47, 50, 61–69, 75, 151, 161, 174–177, 228, 305	sensing of slope, 81, 92, 158, 205, 227
for protein networks, 15, 23, 71, 109, 179	flip-flop, 25, 114	short-circuiting, xiv, 15, 157, 167, 195, 288
for regeneration, 104, 121	general problem, xii	simulations, 79
for signal transduction, 9, 109, 179	glitches, 138	slack, 73
for vein patterning, 177	ground states, 47, 53, 134, 135, 170, 171, 216, 243, 249	solid-state, 300
symbols, 25	impedance of ligand diffusion, 125, 143, 146, 285	SOP selection, 73, 75
circuitry. <i>See also</i> cell signaling; cell states; circuit diagrams; circuits; codes; computation; computer metaphor; gene regulation; links; logic; mechanisms; uncoupling		stability vs. instability, 47, 51, 170, 174, 211, 228, 237
amplification, 13, 47, 122, 188, 209, 211, 286, 300		starting conditions, 236
analog to digital, 72, 81, 158, 209, 251		steady-state, 90
analog vs. digital, 11, 21, 79, 145, 160, 189, 208, 246, 247, 303		stoichiometry, 13, 21, 61, 73, 163, 165, 171, 175, 286, 287, 291, 295, 298, 300, 303
antagonism, 18, 21, 24, 25, 48–51, 61, 71–75, 114–121, 129, 134, 157, 161, 167,		superimposing, 10, 69

- 193, 218, 228, 243, 247, 295, 297. *See also* under positional information
- time constraints, 10, 29, 41, 77, 154, 156
- toggling of activator-repressor modes, 19, 61, 107, 139, 255, 288
- toggling of Delta-Serrate modes, 163, 165, 207
- tracking, 79, 91, 124, 183, 190
- transduction, 20, 27, 35, 72, 81, 134, 285–296
- triggers, 43, 47, 51, 72, 115–119, 155, 157, 169, 207, 217, 297
- triggers, scalar vs. temporal, 11, 133, 215
- virtuosity, 72, 79
- wing veins vs. tracheal branching, 174
- wing vs. notum, 87, 167–173, 190–193
- wiring, *cis-trans*, 136
- circuits, versatile
- Dpp-Wg antagonism, eye disc, 234
- Dpp-Wg antagonism, leg disc, 104, 106, 112–115
- Dpp-Wg cooperation, leg disc, 115–118
- Dpp-Wg cooperation, notum, 190–193
- Dpp-Wg cooperation, wing disc, 157–158, 189–190
- Hh-Dpp, antenna, 205, 249
- Hh-Dpp, leg disc, 105–111, 128–129, 249
- Hh-Dpp, wing disc, 111, 137–145
- Hh-Dpp-Wg, eye MF initiation, 234–236
- Hh-Dpp-Wg, eye MF movement, 229–234
- Hh-Wg, antenna, 205, 249
- Hh-Wg, embryo, 87–91
- Hh-Wg, leg disc, 105–111, 128–129, 249
- Notch, bristle differentiation, 9–15, 25
- Notch, bristle spacing, 47–53, 59, 75, 229
- Notch, eye equator, 203–209
- Notch, leg segmentation, 127, 135–136
- Notch, ommatidial chirality, 209–211
- Notch, photoreceptor identity, 216
- Notch, R8p spacing, 227
- Notch, wing margin, 161–167
- Notch, wing veins, 175–177
- Notch-EGFR, chordotonal organs, 74
- Notch-EGFR, eye-antenna bipolar duality, 169, 235, 302
- Notch-Wg, leg bipolar duality, 114
- Notch-Wg, wing margin, 161–167
- PCP (Wnt?), cell polarity (in general), 293
- PCP (Wnt?), chirality of ommatidia, 209–211
- PCP (Wnt?), polarity of leg joints, 131, 136
- codes. *See also* circuitry
- abstract, 89, 243
- amino acid, 257
- area, 81, 85, 158, 191
- binary, 7, 9, 27, 84, 85, 143, 145, 243, 246, 249
- birthplace, 191
- bitmap, 83
- bristles, 37, 41, 44
- capacity, 83
- combinatorial, 10, 35, 77, 79, 83, 115, 128, 143, 179, 212, 219, 233, 240, 246, 247, 251, 254, 259, 302
- combinatorial vs. hierarchical, 78
- decoding, 209
- disc identity, 84, 85, 240, 251, 254, 302
- Enigma, 33
- general problem, xi, 37, 224, 255, 297
- genetic, 255
- histotypes, 149, 169, 213, 243, 246, 254, 262
- Hox, 28, 191, 239, 240, 246–249
- leg segments, 300
- models, 7, 10, 212
- Morse, 9
- nonsense words, 7
- Numb, 7, 9
- patterns, 101
- photoreceptors, 219, 224, 233
- positions, 84, 101, 104, 124, 158, 213
- transcription factors, 218, 219
- transdetermination, 85, 169
- zinc fingers, 19
- Cohen, Stephen, xii, 129, 137, 143, 157, 173
- compartment boundaries, 4, 91, 105, 273. *See also* boundaries; cell lineage
- blastoderm A/P, 87, 89, 97
- border zones, 107, 111, 125, 137–139, 142, 145, 150–159, 163, 173, 207
- border zones, widths, 112, 137, 142–151, 167, 173, 287, 301
- eye A/P, 91, 199, 201, 299
- eye D/V, 165, 202–211
- in growth control, 92, 118–119, 144, 148
- kinks, 112, 148
- lack of D/V in leg, 100, 111, 159, 170, 203
- leg A/P, 61, 63, 89, 97, 100, 104, 105, 109, 114, 121, 125, 129, 201, 203, 289, 299
- notum A/P, 193
- peripodial membrane, 139
- reestablishment of, 105, 123
- role in disc initiation, 87, 91
- thorax A/P, 89, 96, 97, 103, 111, 128, 148, 156, 287, 288
- wing A/P, 87, 89, 92, 94, 105, 125, 137–154, 173, 177, 186, 189
- wing D/V, 142, 146, 153, 159, 160, 173
- compartments. *See under* cell lineage
- competence, 91, 227, 228, 235. *See also* under bristle patterns; cell signaling; prepatter
- based on transcription factors, 179, 217, 218
- landscape, 84, 134
- need for mitotic quiescence, 69, 304
- region-specific, 109, 111, 117, 148, 153, 164, 166
- states, 148, 217
- suppression of, 135
- vs. determination, 299
- window, 28, 29, 72
- computation. *See also* circuitry; computer metaphor
- absolute vs. relative, 47, 147, 167, 209
- addition, 45, 72
- arithmetic, 72, 73, 188
- bristles, 71–74, 161
- comparison, 47, 71, 72, 91, 167
- critical mass, 133
- distances, 173
- division, 72
- exponential, 72, 81, 83, 158, 301
- Fibonacci series, 304
- growth rates, 124
- integration, 77, 124, 205, 288, 300
- multiplication, 72
- net force vectors, 137
- patterns, xii
- ratio, 68, 72, 89, 124
- shortest path, 93, 123
- step function, 147
- subtraction, 59, 61, 72, 128, 302
- titration, 20–23, 71–73, 287
- with RNA, 73
- computer metaphor. *See also* circuitry; computation
- abstract symbolism, 9, 29, 72, 81, 89, 165, 243, 297
- algorithms, 23, 31, 32, 72
- binary digit (bit), 9, 84, 305
- bitmaps and pixels, 83
- cellular automata, 69, 235
- cybernetics, 173
- gating, 10
- hardware vs. software, 255
- infinite loops, 137, 145
- information processing, 84, 124, 205, 300
- information theory, 81
- input/output, 13, 17, 18, 23, 68, 72, 77, 123, 129, 131, 145, 163, 164, 209, 217, 246, 248, 254, 297–303
- memory registers, 7, 10
- modular subroutines, 7, 169, 299
- program for building a bristle, 36, 297
- program for building an eye, 255
- program vs. blueprint, 297
- resetting of variables, 7, 179, 182
- servomechanisms, 153–155
- Conway, John, 235
- Cooper, Michael, 224
- Couso, Juan Pablo, 300
- Crick, Francis, 101
- cuticle, xi, 5, 28, 87
- pigmentation, 5, 28, 299
- secretion, 5, 29, 40, 41, 73, 87, 199
- thickness, 174
- trichomes (hairs), 28, 65, 99, 159, 199, 247
- two-dimensionality, 31
- Dahmann, Christian, 151
- Davidson, Eric, xiii, 244
- Dearden, Peter, 303
- Demerec, Milislav, 76
- determinants
- asymmetric segregation, 7, 11, 24, 274
- cytoplasmic, 9
- heritable, 5
- determination. *See also* cell states
- adult vs. larva, 9, 86, 87
- all-or-none, 72
- appendage tips, 72
- binary decision trees, 27
- bristle. *See* bristles
- endoderm, 72
- gender. *See* genetics, sex determination
- glial cell fates, 7, 29, 72, 271
- imaginal discs. *See under* imaginal discs
- leg vs. wing, 91
- Malpighian tubule, 72
- mesectoderm, 72, 177
- muscle, 4, 9, 72, 259
- neural. *See* neurogenesis
- potency, 91
- role of HLH genes, 72
- salivary ducts, 72, 91
- stability, 86
- states, 86, 90
- states, maintenance, 90, 247–249
- stepwise, 133, 302
- tracheae, 72, 174
- vs. competence, 299
- vs. differentiation, 175, 185
- wing veins, 177

- development, stages of
embryo. *See under* embryo
larval instars, 49, 85, 87, 92, 121, 133, 148, 161, 208, 224
pupal period, 1, 92, 189, 208, 233
pupariation, xiii, 1, 85
Dexter, John, 298
Dietrich, Wilhelm, 202
differentiation, 5
bristle vs. sensillum, 28
bristle vs. vein, 175
general problem, xi
macrochaete vs. microchaete, 29, 57
shaft vs. socket, 23
vs. determination, 175, 185
vs. growth, 196
waves, 208, 212, 215, 227, 229, 233, 305
DNA
bending, 45, 259–265, 295
binding, 68, 72, 191, 219, 224, 248, 254.
 See also under protein domains, particular
binding affinities, 17, 45, 61, 84, 139, 259, 260, 261, 264, 275
binding screens, 61
binding sites, 15, 17, 19, 49–52, 61, 171, 172, 190, 248, 253, 259–265, 275, 281, 284, 287, 290, 295. *See also* DNA motifs
binding sites, overlapping, 239, 295
binding sites, swapping, 171
binding specificity, 91, 259–263, 303
binding, competitive, 17, 18, 79, 84, 107, 182, 247, 278, 288, 291, 295
binding, cooperative, 79, 84, 263, 265
binding, nonspecific, 260
bookmarking, 249
chromatin, 248, 249
chromatin, spreading, 249, 281
cloning, 38, 40, 148
coding vs. non-coding, 41, 305
endoreplication, 29, 30, 41, 68, 86
euchromatin vs. heterochromatin, 43, 248
footprinting, 239
homology screens, 27
inverted repeats, 17
looping, 41, 45, 161, 191, 249, 261
methylation, 249
open vs. closed states, 249, 305
ploidy, 29, 86
replication, 249
DNA motifs. *See also* protein domains, particular
E box, 17, 48–55, 68–72, 258, 263
homeobox, 28, 29, 85, 90, 115, 132–136, 149, 260–261
N box, 17, 50, 71, 258
T box, 112, 141
Dong, Si, 251
Driesch, Hans, 81, 93, 300, 302
Drosophila
Aristotle's "gnat", xi, 256
artificial selection, 193
genus, 62, 63, 72, 135, 174, 237
giant, xi, 92
Hawaiian, xi, 67, 92, 193
hybrids, 71
melanogaster, xi, 202, 212, 298
other species, 31, 36, 63, 67
polymorphisms, 37
Dubinin, N. P., 37
Duncan, Ian, 251
Ede, Donald, 224, 225, 305
embryo
axes. *See under* axes
blastoderm, 35, 77, 79, 89, 90, 97, 237
blastoderm cells, 77, 86, 87
blastoderm clones, 90, 199
cell transplantation, 77, 86
cleavage, 4
dorsal closure, 151
ectoderm, 77, 86–90, 109, 191
endoderm, 72
epidermis, 125
fate maps, 76, 77, 91, 245
gastrulation, 177
gliogenesis, 72
maternal gene products, 87
mesectoderm, 72, 177
mesoderm, 239
metameres, 76, 79, 84, 239, 246, 247, 254
myogenesis, 4, 9, 28, 72, 259
neuroectoderm, 50, 299
neurogenesis. *See* neurogenesis
pair-rule stripes, 35, 45, 77–79, 84, 177
quirks of patterning, 86
salivary ducts, 72, 91
segmental gradients, 84
segmental identities, 79
segmentation, 76–80, 239, 299
segments vs. parasegments, 78, 84, 237–246, 305
stages, 85, 86, 90
tracheal system, 72, 151, 174
Wingless stripes, 78, 109
embryonic fields, 37, 43, 81, 86, 87, 190
emergent properties, 87, 89, 101, 107, 131–134, 142, 145, 153, 159, 160, 164, 177, 208–209, 213, 234, 236, 299, 302, 303
endocytosis, 26, 53, 180, 259
engineering, mechanical, 177, 227, 303
epidermis, 31
epiphanies, 270
equivalence groups, 37, 39, 43, 47, 49
evolution
accidents, 31, 288
allometry, 299
arbitrariness, 158, 300
artificial selection, 31, 55, 193
Bateson's Rule, 237, 300
by atavism, 246
by cobbling, xiv, 62, 297
by co-option, 10, 31, 72, 109, 136, 239, 246, 261
by crosslinking, xi, 36, 246, 255, 298, 305
by elaboration, 63
by gene duplication, 298
by gene sharing, 298
by genetic drift, 68, 71
by heterochrony, 69, 299
by heterotopy, 300
by hopeful monsters, 237, 246, 267
by tinkering, 63, 148, 255, 299, 302
by transposon jumping, 298
constraints, 92, 158, 300
default states, 299
entelechy, 300
epigenetic landscape, 300
evo-devo biology, 189
evolvability, 255, 264, 265
fine-tuning, 228
frivolity, 31, 302
genetic workload, 247
improvisation, xiv
inelegance, xiv, 35
legacies, 31, 132
loss through disuse, 68
missing links, 63
of anatomy, 255
of antennae vs. legs, 252, 300
of appendages, 243
of binding affinities, 264
of body vs. leg segmentation, 136
of bract-bristle adhesion, 67
of bristle patterns, 31, 36, 62, 65, 69, 255
of bristles, 28, 29, 30
of circuitry, xi, 10, 31, 36, 63, 69, 72, 77, 136, 158, 173, 186, 223, 239, 244–247, 255, 262, 288, 299, 302, 305
of competence, 36, 246
of endocrine systems, 246
of eyes, 197, 223
of gene complexes, 36, 239, 243, 255, 298
of gene hierarchies, 303, 305
of genitalia, xii, 252
of halteres, 243, 246
of HLH genes, 68, 72, 305
of insects, 299
of leg segments, 300
of legs, 132
of metameres, 243
of modules, 63, 255, 264, 265, 297, 299
of opsins, 223
of organ shapes, 148
of protein domains, 257, 265
of proteins, 68
of receptor proteins, 286, 290, 297
of sex combs, 36, 63, 135
of sex determination, 72
of sexual behavior, 305
of tissue polarity, 235
of toggle switches, 255
of vein patterns, 174
of wings, 86
opportunism, xiv, 302
optimization, 79
reprogramming, 10, 63, 72, 246
strategies, 165, 303, 305
vs. engineering, 158
eye
anatomy, 197, 199
axes. *See under* axes
ectopic, 252–254
equator, 198, 202–211, 296
equators, extra, 203, 207
fovea, 199
identity ("eyeness"), 240, 247, 302
missing, 169, 228, 231, 252
ommatidia. *See* ommatidia
other insects, 212, 302
perimeter, 230
pigmentation, 197, 302
scar phenotype, 229
small, 169, 207, 228, 231
split phenotype, 17, 50
eye disc, 96
bipolar duality, 114, 169, 235, 302
cell death, 87
compartments, A vs. P, 91
fate map, 87, 199
gene expression patterns, 169, 203–209, 216–220, 233
head capsule, 204, 296
initiation, 77, 207

INDEX

447

- invagination, 91
 lattice tightening, 87, 227–228
 maxillary palp, 191, 199, 240
 MF (morphogenetic furrow), 44, 208–211, 215, 227, 233
 MF engine, 229–234
 MF initiation vs. progression, 231, 234–236, 253
 MF vs. compartment boundaries, 229–234
 ME, adhesive molecules, 281
 ME, speed of, 229, 234
 ME, straightening of, 151
 MFs, collision of opposing, 236
 MFs, extra, 212, 231–236
 MFs, hot spot for, 231
 mitotic band, 208, 211, 233
 nomenclature, xiii, 199
 ommatidia. *See* ommatidia
 peculiarities, 91
 photoreceptors. *See* photoreceptors
 regional markers, 207
 role of EGFR pathway, 179
 role of peripodial membrane, 304
 transcription factors, 182, 218
- eye field
 as a cellular automaton, 235
 initiation, 253
 margins, 231, 234–236, 253
 MF initiation site, 235
 mosquito, 212
- fate maps, xiii, 92
 embryo, 77, 91, 245
 eye disc, 87, 199
 leg disc, 96, 99, 105, 106, 111, 128
 peripodial membrane, 87, 122, 139
 wing disc, 94, 139, 156, 193, 301
- Fernández-Fúnez, Pedro, 160
 Freeman, Matthew, 216, 217
 French, Vernon, 93
- García-Bellido, Antonio, 4, 32, 52, 85, 148, 155, 243
 Gehring, Walter, xii
- gene complexes
 ANT-C, 237–243, 248, 260
 AS-C, 17, 28, 30–75, 191, 193, 245, 272, 299, 305
 Bar-C, 28, 134, 169, 194, 219, 220, 228, 233, 298
 Brd-C, 272, 279
 Broad-C, 20, 217, 223, 259
 BX-C, 38, 45, 237–243, 246, 248, 260, 298, 299, 305
 E(spl)-C, 10, 15, 17, 44, 48–51, 61, 68, 73, 218, 258
engrailed-invected, 141, 149, 243
 homeobox, 243
 homunculi, 45, 239
 Hox, 239, 298
 Iro-C, 96, 142, 166, 186, 187, 190–194, 203–208, 235, 236, 242, 243, 300, 302
 Kni-C, 186
 Spalt-C, 186, 187, 224
- gene expression. *See also* under eye disc; leg disc; wing disc
 antenna, 91, 193, 205, 251, 288–296, 302
 antenna vs. leg, 159, 251
 arcs, 115, 127
 at boundaries, 167, 171, 207, 209, 296
 at interfaces, 87, 89, 107, 131–134, 142, 145, 153–155, 159, 160, 164, 177, 234, 302, 303
 bands, 77, 127, 131, 136, 137, 141, 186, 205, 251
 basal transcription level, 107
 biscuits vs. bands, 151, 157
 biscuits vs. doughnuts, 137, 138, 151
 cages, 122, 123, 125, 137
 cell-size independence, 92
 circles, 104, 115, 117, 127, 129, 131, 137, 205, 251
 coexpression, forced, 143, 157, 253, 265, 291
 coexpression, natural, 59, 131, 135, 164–166, 171, 172, 179, 183, 208, 302
 coexpression, paradoxical, 47, 91, 107, 114, 128, 139, 142, 219
 coexpression, spatial but not temporal, 71
 compartment-specific, 89, 104, 111, 112, 117, 121, 141, 146, 148, 153, 158–164, 203–207, 245, 285, 287
 complementarity, 41–44, 59, 69, 78, 125, 129–135, 141, 143, 158, 169, 174, 175, 184, 188, 193, 301, 302
 constitutive, 107
 drivers, artificial, xiii, 7, 13, 30, 50, 51, 107, 113, 182, 216, 253
 drivers, strong, 144, 157
 drivers, weak, 138, 145, 154, 157
 dynamics, 69, 78, 79, 127, 131, 134, 164, 167, 171, 188–191, 208, 218, 224, 234, 246, 247
 enhancer traps, 112, 114, 127, 193, 205, 223, 300, 301
 enzyme patterns, 301, 302
 fuzzy zones, 128, 169, 193, 305
 gradients, 127, 129, 135, 143, 177, 235
 halos, 143, 156
 hiatuses, 117
 maintenance, 90, 107, 131, 160, 164, 166, 171, 247–249
 nonfunctional, 172, 189, 218
 nonuniform, 45, 69, 78, 84, 154, 243, 247, 249, 281, 305
 ON/OFF boundaries, 89, 121, 131, 136, 153, 157–160, 165, 173, 177, 186, 191, 203, 207, 209, 234, 235, 299, 303
 ON-then-OFF, 48, 91, 151, 184
 overlaps, 77, 79, 128, 142, 145, 157, 167, 169, 172, 193, 251, 302, 303
 overlaps, transient, 127, 129, 131, 134
 parabolic regions, 104, 112
 perdurance, xv, 125, 139, 147, 166, 167
 periodic, 127, 136, 300
 punctate, 157, 233
 response to trauma, 98, 100, 119, 123
 rings, 105, 112, 126–136, 141, 151, 205, 218
 sectors, 104–106, 109, 112, 117, 121–128, 133, 141, 169, 205, 301
 segmental vs. parasegmental, 246
 single files of cells, 127, 135, 139, 145, 175, 177, 217
 spreading, 119–122, 127, 145, 166, 171, 242, 288, 291
 stratified (rainbow), 78, 131, 138–142, 157, 164, 188–193, 234
 stripes, antenna, 251
 stripes, antineural, 59–62, 69
 stripes, ectopic, 68, 115, 117, 157, 171
 stripes, embryo, 35, 77, 78, 89–91, 109, 293
 stripes, eye D/V boundary, 207, 209
 stripes, eye D-V axis, 233
 stripes, eye furrow, 215, 233, 234, 304, 305
 stripes, eye margins, 234
 stripes, interveins, 177, 183
 stripes, leg A/P boundary, 109, 111, 125, 129
 stripes, leg disc, 112, 127, 128, 251
 stripes, leg proximal-distal axis, 61, 112, 302, 304
 stripes, notum, 104, 190–193, 304
 stripes, pigment, 193
 stripes, proneural, 59, 61, 62, 71, 163, 280
 stripes, tarsus, 61, 302
 stripes, widths of, 47, 59, 61, 89, 112, 127, 128, 137, 140–151, 163, 167, 173–177, 233, 287, 303
 stripes, wing A/P boundary, 111, 128, 137, 142–147, 301
 stripes, wing D/V boundary, 141, 146, 157, 159, 163, 164
 stripes, wing disc, 141, 142, 157
 stripes, wing veins, 47, 175, 177, 183–186, 303
- gene families *See also* protein domains, particular
 Bearded, 17, 271, 272
 Bright, 223, 292
 Frizzled, 293
 Gli, 287
 GRIP, 290
 Hedgehog, 105
 Hox, 239, 248
 IκB, 258
 LIM-HD, 71, 260
 MAGUK, 260, 283
 Notch, 258
 olfactory receptor, 191
 POU-HD, 71, 260
 Pox-Pax, 242, 262
 Rel, 258
 RTK, 179
 Shc, 264
 Smad, 290
 steroid receptor, 217
 Tcf, 258
 TGF-α, 170
 TGF-β, 105, 115, 189, 289, 290
 Wnt, 105, 115, 292
- gene groups
Minute, 21, 29, 52, 56
 Pc-G, 65, 111, 135, 207, 239, 242, 243, 247–251, 264, 300
 Trx-G, 111, 239, 242, 243, 247–251, 276
- gene regulation. *See also* circuitry
 activator-repressor switching, 19, 61, 107, 139, 255, 288
 activators, 9, 13, 17, 51, 72, 73, 107, 133, 193, 239, 248, 249, 254, 261, 262, 290
 activators, unknown, 107
 auto-activation, 47–51, 72, 91, 107, 171, 193, 219, 233, 234, 248, 291, 295
 auto-regulation, 72, 147, 171, 248
 auto-repression, 17, 18, 107, 132, 147, 153, 166, 182, 225, 248, 263, 285, 288, 291, 295
 basal transcription apparatus, 45, 298
 batteries, 87, 217, 246
 bipolar regulators, 19, 107, 255, 288
 Britten-Davidson Model, 244
 by cell-surface receptors (direct), 12, 175

- gene regulation (*contd.*)
by chromatin-remodeling, 17, 71, 111, 207, 239, 247–249, 264, 282, 295, 300
by micromanagers, 245–249, 253, 254
by nuclear import, 131, 133, 172, 181, 242, 251, 287, 288, 294
by proteolysis of regulators, 19, 20, 105, 107, 133, 182, 224, 263, 271, 295
cis-enhancers, 44–45, 79, 84, 92, 107, 128, 136
cis-enhancers, arrays of, 18, 21, 35–44, 52, 53, 72, 129, 131, 141, 164, 174, 188, 239, 289, 299
cis-enhancers, boundary vs. quadrant, 157, 164, 171, 245, 301
cis-enhancers, cell-type specific, 11, 48, 51, 219, 224, 254
cis-enhancers, colinear vs. scrambled, 41, 45, 239
cis-enhancers, constitutive, 171
cis-enhancers, disc-specific, 292
cis-enhancers, distant, 161
cis-enhancers, embryonic vs. imaginal, 245, 249
cis-enhancers, evolution of, 255
cis-enhancers, genomic repertoire of, 255
cis-enhancers, parasegment-specific, 243
cis-enhancers, region-specific, 28, 35, 36, 41–48, 191, 219, 239, 245, 249, 253, 289, 299
cis-enhancers, shared, 44, 298
cis-enhancers, stage-specific, 45, 86, 92, 128, 164, 174, 188, 227, 249, 289, 305
cis-regulatory region, 17, 71, 87, 239
cis-silencers, 62, 239
co-activators, 12–15, 91, 223, 264, 265, 288, 291, 295
combinatorial, 77, 136, 219, 245, 253, 254, 301
co-repressors, 12, 17, 49, 51, 61, 71, 207, 259, 264, 265, 281, 295, 302
default states, 173. *See also under* circuitry
direct vs. indirect, xiii, 51, 107, 111, 128, 139, 141, 156, 164, 172, 187, 191, 193, 205, 219, 245, 248, 271, 288
enhanceosomes, 254, 255, 260, 300
enhancer-promoter bridging, 41, 45, 160, 161, 191, 279, 284
enhancer-promoter specificity, 45
hierarchies, 45, 69, 75–79, 83, 103, 133, 136, 141, 149, 182, 186, 217, 239, 244–248, 253, 303
histone acetylation, 248, 279, 288
histone deacetylation, 17, 248, 249, 275, 276, 281
insulators, 161
introns, 49, 171, 292
leg vs. wing disc, 137, 157, 164–170
licensing agents, 233, 254
locked-OFF vs. passive-OFF, 172, 173, 285, 294, 295
Mediator complex, 45, 135, 254, 300
networks, 79, 205, 246, 253, 303
open-for-business idea, 218
post-transcriptional, 48, 69, 72, 78, 79, 133, 234
post-translational, 68
promoters, 13, 15, 18, 45, 48, 50, 52, 55, 61, 72, 81, 253
puffing cascade, 20, 217
qualitative vs. quantitative, 44, 72, 81, 138, 139, 158
quenching vs. squelching, 17, 71, 79, 249, 295
Ras-dependent, 179
relays, 112, 141, 145, 177, 205, 215, 233
repressors, 13, 17, 18, 47, 48, 68, 72, 107, 135, 187, 190, 239, 248, 249, 261, 264
repressors, unknown, 171
stage-specific, 166, 246, 248, 249
synergy, 12, 52, 71, 75, 157, 181–185, 191, 252–254, 273, 275, 279, 281–283
trans-acting factors, 36, 43–45, 69, 72, 79, 245, 249, 298, 299
transcription cofactors, 190
transcription factors, 35, 51, 107, 181, 186, 190, 218, 260
transcription factors, landscape of, 301
triggers, 100, 133, 234
triggers, interface, 87, 89, 107, 131–134, 142, 145, 153–155, 159, 160, 164, 167, 171, 177, 207–209, 234, 296, 303
triggers, temporal, 91, 121, 123, 129, 137, 141, 145, 164, 299
genes. *See also* gene regulation; genes, particular; genetics; mutations; phenotypes; protein domains, particular
abbreviations, xv, 37
adult vs. larval, 87
annulus, 127
antineural, xiii, 48, 53, 59, 62, 71–75, 163, 164, 180, 281, 282
autonomy in clones, 1, 33, 35, 39, 48, 50, 72, 80–85, 89, 124, 133, 141, 143, 148, 160, 165, 177, 183, 186–190, 209, 219, 245, 251, 282, 290
axis, 76, 147
boundary, 165
cascades, xiv, 20, 217
cassettes, xi, 47, 72, 305
cell cycle, 49, 258
cell type, 243
co-adapted, 71
co-expressed (naturally), 59, 135, 164–166, 171, 179, 208
colinearity, 45, 298
competence, 35, 45
cooperativity, 172
default states, 11, 59, 169, 171, 251, 299
disc-specific, xi, 159
dispensable, xiii, 24, 48, 86, 117, 157–159, 175, 182, 216, 218, 235
dispensable pairs, 79, 287
duplications, 36
early eye, 169, 235, 242, 252–254, 302
event-counting, 11
executive, 135
field-specific, 242, 243, 254
gap, 77, 79, 84, 136, 147, 158, 186, 239
genomic repertoire of, 255
homeotic, 28, 65, 78, 83–86, 237–240, 247–249, 260
homologs, xii, 11, 13, 23, 26, 75, 109, 170, 179, 181, 239, 257, 274, 275, 283, 294, 304
housekeeping, 29, 85, 100, 302
Hox, 79, 80, 245–249, 254, 260
human, 13, 171, 254, 258, 259, 265, 290, 299, 303
instructive vs. permissive, xiv, 9, 36, 130–134, 189, 191, 215, 234, 249
interchangeability, 44
intronless, 17, 41, 73, 265
limiting factors, 21, 29, 69
mammals, 13, 15, 23, 26, 75, 225, 249, 258–265, 274, 275, 283, 295
map locations, xii
master, 85, 171, 242, 252–254, 260, 297
maternal-effect, 76
memory, 10, 65, 81, 83, 84, 129, 158, 239, 248, 251
metamere identity, 239, 254
misexpression, xiii, 86
modifiers, 12
necessary vs. sufficient, xiii, 37, 118, 132, 136, 245
nematodes, 261, 263, 295
neural precursor, 271
neurogenic, xiii
nomenclature, xii
nonautonomy, 39, 47, 48, 80, 133, 141, 177, 183, 186, 203, 209, 228, 231, 246, 303
ON/OFF states, 1, 28, 79, 83, 84, 89, 107, 111, 143, 148–153, 158–160, 179, 239, 243–249
orthologs, xiii, 171, 258, 265, 283, 289, 290, 303
overexpression, xiii, 49
pair-rule, 18, 35, 77, 79, 84, 136, 158, 262, 278
pan-neural, 72, 182, 272, 274, 279, 284
paralogs, xii, 10, 141, 149, 181, 186, 219, 223, 253, 285, 289, 298, 303
pathways, xiii, xiv
periodic-zone, 136
pinwheel, 97
plant, 239, 260, 261
prepatter, 27, 33, 35, 39, 45, 80, 148, 164, 193, 219, 278, 299
proneural, xiii, xiv, 37, 39, 41, 45, 49–53, 71–75, 161, 225, 229, 271, 279, 280, 283, 284
rate, 299
realizor, 134, 149, 174, 186, 246, 260, 305
redundant, xiii, 9, 10, 12, 17, 18, 21, 28, 40, 44, 45, 48, 55, 62, 75, 91, 125, 129, 134, 141, 149, 158, 167, 175, 218, 227, 231, 272, 278, 279, 281, 293, 295, 298, 300, 303
reporter, xiii, 28, 41, 48–52, 61, 117, 171, 191, 207, 219, 239, 291, 301
ribosomal RNA, 29
segmentation, hierarchy of, 76–80, 83, 103, 136, 186, 239, 247, 248, 303
segment-polarity, 79, 89, 97, 123, 131, 136, 158, 293
selector, 29, 48, 85, 89, 141, 145, 149–163, 173, 174, 188, 203, 246, 248, 262
selector, PI mode, 89, 145, 148, 163, 243
sensillar identity, 27, 75
sex determination, 30, 49, 72
subgenes, 37
switch, 9–11, 24, 28, 48, 85, 132, 148, 159–161, 165–169, 181, 184, 191, 207, 218, 240, 243, 255, 261, 271–284, 302
thin-zone vs. wide-zone, 136
ubiquitously expressed (naturally), 17, 49, 51, 59, 69, 75, 85, 92, 133, 158, 160, 161, 164, 225, 251, 263, 265, 274, 280, 282, 283, 290, 294
untranscribed, 191
upstream vs. downstream, xiv, 45

- vertebrate, xiii, 71, 109, 141, 179, 181, 225, 239, 258–261, 283, 285, 289, 290, 294, 305
work loads, 247
yeast, 258, 260, 261, 265
zygotic, 77
genes, particular
 14-3-3 ζ , 179, 180
 18 wheeler, 300
 abdominal-A (*abd-A*), 78, 239, 242
 Abdominal-B (*Abd-B*), 78, 239, 242
 abl oncogene, 223
 abnormal chemosensory jump 6 (*acj6*), 271
 abrupt, 303
 Abruptex (=Notch), 52, 195, 279
 absent solo-MD neurons and alfactory sensilla (*amos*), 27, 28, 75, 254, 276
 absent, small, or homeotic discs 1 (*ash1*), 242
 absent, small, or homeotic discs 2 (*ash2*), 242, 276
 achaete (*ac*), 17, 30–75, 91, 112, 128, 141, 142, 161, 163, 167, 177, 187–195, 225, 229, 278, 279, 292, 296, 301–303
 Actin5C, 138
 Additional sex combs (*Asx*), 242
 Antennapedia (*Antp*), 78, 81, 83, 85, 96, 131, 239, 242, 246, 249, 251
 anterior open, 169
 approximated, 185
 apterous (*ap*), 127, 141, 158–173, 248, 260, 296, 301
 araucan (*ara*), 142, 177, 185–194, 203–208, 235, 242, 289, 292, 296, 302, 303
 arc, 292
 argos, 52, 147, 170, 177–188, 194, 215–218, 223, 227–229, 242, 303–305
 aristaleless (*al*), 92, 115, 117, 127–136, 141, 171, 251, 278, 292, 295, 300
 aristapedia (=spineless), 80
 Aristapedoid (*Arp* = *Su(z)2*), 242
 armadillo (*arm*), 105–109, 118, 128, 134, 156, 163, 171, 173, 182, 194, 205, 242, 255, 258, 260, 294
 arrow (*arr*), 106, 109, 205, 231, 293, 295
 Arrowhead, 300
 asense (*ase*), 17, 18, 37, 41, 48, 69, 272, 279
 asteroid (*ast*), 185
 atonal (*ato*), 27, 28, 73, 74, 212–235, 258, 276, 289, 296, 304, 305
 baboon, 289
 BarH1, 127, 131, 134–136, 193, 194, 205, 219, 220, 233, 276, 292, 296, 300
 BarH2, 127, 134, 194, 219, 220, 233, 276, 300
 bazooka, 11, 24, 271
 Beadex, xiii, 71, 161, 260
 Bearded (*Brd*), xi, 10, 12, 73, 272, 279
 bicoid (*bcd*), 76–79, 84, 158, 239, 254
 big brain (*bib*), 49, 55, 271, 279
 Big brother, 223
 bithorax (see *Ubx*), xiii, 80, 87, 237
 blind spot (=poils aux pattes), 223
 blistered (*bs*), 111, 141, 172–174, 177, 186–188, 245, 261, 289, 301, 303
 bobbied, 29
 Brachyury (vertebrate), 141
 brahma (*brm*), 242
 breathless, 179
 bric à brac (*bab*), 127, 129, 135, 251, 259, 300
 bride of sevenless (*boss*), 15, 179, 180, 213–220, 224, 305
 brinker (*brk*), 109, 112, 141, 142, 148, 157, 265, 291, 292
 Brista (=Distal-less), 251
 Broad-Complex, 20, 259
 Brother, 223
 Brother of Brd (*Bob*), 73
 canoe (*cno*), 11, 75, 180, 263, 271, 279
 Casein Kinase 2 (*CK2*), 109, 273, 293, 294
 CASK, 260
 castor, 217
 caudal (*cad*), 77–79
 caupolican (*caup*), 142, 177, 186–194, 203–208, 242, 289, 292, 296, 303
 Cfla (=ventral veinless), 260, 263
 chaoptic, 223
 chickadee, 29
 Chip, 45, 160–166, 191, 260
 Clock, 263
 clown, 180
 collier (=knot), 142, 259
 comb gap (*cg*), 111, 135, 285, 292
 congested-like trachea (*colt*), 174
 connector enhancer of *ksr* (*cnk*), 180, 182
 corkscrew (*csw*), 179, 180, 182, 303
 costal2 (*cos2*), 109, 154, 157, 194, 286
 cousin of atonal (*cato*), 272
 cramped (*crm*), 135, 242
 crooked legs (*cro*l), 127
 crossveinless, 189
 crossveinless 2, 189, 289
 crossveinless-like 6, 189
 C-terminal Binding Protein (*CtBP*), 21, 61, 71, 190, 193, 259, 264, 273, 280, 282, 291
 cubitus interruptus (*ci*), 105–112, 124, 128, 141–153, 165, 171, 186, 187, 205, 233, 242, 261, 285, 287
 cut, 27, 141, 142, 161–166, 219, 220, 233, 242, 243, 259, 276
 cycle, 263
 Cyclin (*genes A-F*), 44, 49, 233, 260, 280
 dacapo, 11
 dachs, 135, 185
 dachshund (*dac*), 127–135, 205, 220, 223, 228, 235, 242, 251–254, 261, 287, 292, 295, 300
 dachsous, 185, 209, 293
 dActivin, 289
 dally-like (*dip*), 293
 dAP-2, 127
 daughter of sevenless (*dos*), 179, 180, 182, 303
 daughterless (*da*), 49, 50, 69–75, 113, 173, 174, 191, 223–228, 233, 263, 276, 280
 Daughters against *dpp* (*Dad*), 109, 134, 141, 148, 167, 190, 290–295
 *dAxi*n, 109, 115, 118, 292, 294
 DC0, 105, 109–119, 149–157, 187, 194, 231, 287, 303
 dC3G, 180, 182
 dCable (*dCbl*), 179–181
 dCdc37, 179
 dCdc42, 234
 DCP-1, 228
 dCul-1, 189
 dE2F, 295
 dead ringer, 223
 deadpan (*dpn*), 17, 72, 127, 223, 265, 274, 300
 dE-cadherin, 109, 153, 294
 decapentaplegic (*dpp*), 39, 89, 90, 104–129, 133–134, 137–158, 170–177, 185–194, 205, 228–235, 245, 252, 253, 288, 289, 295, 301, 303, 305
 Deformed (*Dfd*), 78, 239
 Delta (*Dl*), 9, 12, 15, 25, 47–50, 59, 61, 71, 75, 124, 127, 135, 160–169, 173–177, 203–211, 215, 216, 223–229, 242, 254, 259, 271, 272, 280, 296–300, 303–305
 deltex (*dx*), 12, 15, 135, 175, 272, 280
 Dense, 278
 derailed, 179
 Dfrizzled2 (*Dfz2*), 105, 109, 125, 146, 158, 190, 194, 293, 295
 Dfrizzled3 (*Dfz3*), 104, 112, 125, 141, 142, 158, 295
 dHSF, 254
 Dichaete, 31, 45, 194, 195, 265, 280
 disconnected (*disco*), 127, 136
 discs large, 271
 discs overgrown, 263
 dishevelled (*dsh*), 15, 106, 109, 114–118, 124, 131–136, 163, 167, 193, 194, 205–209, 242, 279, 293
 dispatched, 125, 185, 285
 Distal-less (*Dll*), 29, 86–90, 96, 104, 115, 117, 127–137, 141, 142, 148, 156, 158, 205, 242, 247–254, 292, 295, 300–303
 division abnormally delayed (*dally*), 105, 109, 146, 194, 290, 293
 dJun, 179–182, 209, 215, 220, 293
 dLim1, 127, 135, 240
 dMyc, 92
 Domina (=jumeaux), 278
 dorsal, 254, 255
 Dorsal switch protein 1 (*Dsp1*), 242
 Dorsal wing (*Dlw*), 159–163, 166, 167
 doublesex, 30
 double-time (=discs overgrown), 263
 downstream of receptor kinases (*drk*), 179–182, 303
 dPax2, 28, 29, 219, 220, 233
 dRac1, 180, 182, 293, 295
 dRacGap, 180, 182
 dRaf, 107, 153, 169, 170, 179–188, 194, 231, 242, 258
 dRasGap, 304
 Dredd, 228
 drICE, 228
 drifter (=ventral veinless), 174
 Drop, 228
 Drosophila CREB-binding protein (*dCBP*), 107, 109, 111, 288, 291, 295
 Drosophila Dr1-associated protein (*dDrap*), 71
 Drosophila Heat shock protein 90 (*dHsp90*), 180
 Drosophila MAPK-ERK Kinase (*dMEK*), 169, 179–182, 304
 Drosophila Mitogen-Activated Protein Kinase (*dMAPK*), 169, 179–183, 216, 218, 223, 227, 235, 259, 304
 dSara, 289
 Dscam, 191, 261
 dShc, 179, 180, 182, 303
 dTrk, 179
 dumpy, xi, 174, 259
 DWnt-4, 292
 ebi, 180
 ebony, 193
 ecdysoneless, 278

genes, particular (<i>contd.</i>)	<i>hairless (H)</i> , 18, 20–28, 51, 52, 75, 175, 273, 282, 305	<i>moira</i> , 107, 242
<i>echinoid</i> , 223	<i>hairy (h)</i> , 17, 32, 45–49, 61–63, 68–75, 112, 127, 128, 136, 163, 177, 187, 193, 195, 205, 223, 233, 234, 264, 265, 282, 289, 292, 296, 302, 304, 305	<i>Mothers against dpp (Mad)</i> , 109, 126, 128, 131, 141, 143, 147, 171, 190–191, 229–235, 253, 255, 290
<i>echinus</i> , 278	<i>head involution defective (hid)</i> , 228	<i>multi sex combs (mxc)</i> , 135, 242
<i>embryonic lethal, abnormal vision (elav)</i> , 223, 273	<i>heartless</i> , 173, 179	<i>multiple ankyrin repeats single KH domain (mask)</i> , 180
<i>enabled</i> , 300	<i>hedgehog (hh)</i> , 79, 89, 90, 104–112, 117, 119–129, 137–160, 165, 171, 174, 177, 185–187, 194, 205, 208, 212, 223, 228–235, 242, 253, 285, 288, 292, 301, 305	<i>musashi (msi)</i> , 24, 264, 273
<i>engrailed (en)</i> , 61, 78, 79, 87–91, 107, 111, 112, 117, 121, 124, 137–163, 170, 182, 187–189, 205, 209, 224, 229, 239, 246, 248, 288, 299, 301, 303	<i>homothorax (hth)</i> , 112, 127–136, 141, 148, 166, 205, 242, 251, 249–254, 261, 262, 292, 296, 300–302, 305	<i>muscleblind</i> , 220
<i>Enhancer of Ellipse 24D (=echinoid)</i> , 180	<i>huckebein</i> , 265	<i>myoglianin</i> , 289
<i>Enhancer of Ellipse, 24D (=echinoid)</i> , 230	<i>hunchback (hb)</i> , 78, 79, 217, 239, 254	<i>naked cuticle</i> , 292
<i>Enhancer of split (=m8)</i> , 9, 17, 272, 281	<i>hyperplastic discs</i> , 135	<i>naked cuticle (nkd)</i> , 112, 134, 167, 230, 295
<i>Enhancer of zeste</i> , 135	<i>inscuteable (insc)</i> , 24, 271	<i>nanos</i> , 76, 79
<i>Epidermal growth factor receptor homolog (Egfr)</i> , 29, 56, 73, 106, 153, 169, 170, 173, 177–188, 194, 205, 212, 215–218, 227, 228, 242, 264, 281, 288, 297, 300, 303, 305	<i>Insulin receptor</i> , 179	<i>nemo</i> , 292, 303
<i>Epithelial Adenomatous Polyposis Coli (E-APC)</i> , 109, 258, 294	<i>invec ted (inv)</i> , 141, 145, 149, 153, 161, 301	<i>net</i> , 173, 174, 177, 185, 303
<i>escargot (esg)</i> , 89, 91, 127, 131–136	<i>I-POU (=acj6)</i> , 71, 260	<i>neuralized (neu)</i> , 147, 156, 273, 282
<i>even skipped (eve)</i> , 45, 78, 262	<i>irregular chiasm C-roughest</i> , 215	<i>NK-4</i> , 255
<i>expanded</i> , 209, 289, 293	<i>jumeaux</i> , 271	<i>Notch (N)</i> , xiv, 9, 12–17, 25, 47, 49, 61, 71–75, 106, 114, 124, 135, 147, 157, 160–177, 185, 188, 194, 203–211, 215–219, 227, 229, 235, 242, 245, 259, 264, 271, 273, 278, 283, 297–299, 301, 304, 305
<i>extra eye (ee)</i> , 242	<i>Jun N-terminal Kinase (JNK)</i> , 180, 209, 259, 293	<i>Notchless (Nle)</i> , 283
<i>extra sex combs (esc)</i> , 80, 135, 242, 249, 265	<i>kakapo</i> , 257	<i>Notum</i> , 242, 292
<i>extradenticle (exd)</i> , 111, 131–134, 166, 195, 205, 242, 251–254, 260–262, 300–302	<i>karst</i> , 180	<i>nubbin (nub)</i> , 127, 167, 171, 263, 301
<i>extramacrochaetae (emc)</i> , 47, 48, 71–75, 141, 142, 161, 174, 175, 193, 194, 223, 233, 234, 260, 281, 301–303	<i>kekkon1 (kek1)</i> , 177–183, 303	<i>numb</i> , 5–27, 72, 165, 259, 264, 266, 270, 274, 286
<i>eye gone (eyg)</i> , 223, 235, 242, 252, 262	<i>kinase suppressor of ras (ksr)</i> , 179, 180, 182, 258	<i>numb-associated kinase (nak)</i> , 24, 274
<i>eyeless (ey)</i> , 80, 205, 228, 235, 237, 242, 249, 252–254, 292, 296	<i>kismet (kis)</i> , 242	<i>Numbl like (mouse)</i> , 15
<i>eyelid (=osa)</i> , 223, 292, 305	<i>kl ingon</i> , 218	<i>odd Oz (odz)</i> , 127, 136, 278
<i>eyes absent (eya)</i> , 205, 220, 228, 235, 242, 252–254, 261, 287, 292	<i>klumpfu ss (klu)</i> , 48, 127, 271, 282, 300	<i>odd paired (opa)</i> , 262
<i>fasciclin II (fas II)</i> , 127, 131, 134, 151, 281	<i>knirps (kni)</i> , 78, 141, 174, 177, 186, 239, 264	<i>odd skipped (odd)</i> , 78, 79, 127, 134, 136
<i>fat facets (faf)</i> , 180, 223	<i>knirps-related</i> , 186	<i>Odorant receptor 83b (Or83b)</i> , 191
<i>fat-head</i> , 107, 153	<i>knot</i> , 139, 142, 147, 177, 183–187, 259, 289, 301, 303	<i>on ecut</i> , 220
<i>flamingo (=starry night)</i> , 209, 293, 304	<i>kohtalo</i> , 223	<i>ophthalmoptera (opht)</i> , 242
<i>forked</i> , 29	<i>Krüppel (Kr)</i> , 78, 239, 254, 264	<i>Ophthalmoptera (Opt)</i> , 203, 242
<i>four jointed (fj)</i> , 127, 135, 185, 205, 301	<i>kuzbanian (kuz)</i> , 49, 53, 135, 175, 258, 282	<i>optix</i> , 235, 242, 252, 253
<i>fringe (fng)</i> , 15, 52, 135, 159–167, 173, 194, 203–208, 242, 279, 300	<i>l(1)ts504</i> , 135	<i>optomotor-blind (omb)</i> , 111–113, 118, 125, 133, 140–143, 154, 155, 158, 187, 205, 245, 291, 292, 296, 301, 303
<i>fringe connection (frc)</i> , 292	<i>l(3)1215</i> , 300	<i>oroshigane</i> , 185, 285
<i>frizzled (fz)</i> , 125, 131, 136, 146, 158, 181, 205, 209–211, 293, 304	<i>L38</i> , 257	<i>orthodenticle</i> , 205, 220, 289, 296, 300, 305
<i>fruitless</i> , 305	<i>labial (lab)</i> , 239, 242	<i>osa</i> , 242
<i>fused (fu)</i> , 109, 149, 185, 286	<i>leg arista wing complex (lawc)</i> , 242	<i>paired (prd)</i> , 262, 264
<i>fushi tarazu (ftz)</i> , 18, 77, 78, 239, 254	<i>lethal (2) giant discs (l(2)gd)</i> , 115, 157	<i>paired box-neuro (poxn)</i> , 27, 127, 262, 277
<i>futsch</i> , 215	<i>lethal (2) giant larvae (lgl)</i> , 24, 273	<i>pangolin (pan)</i> , 105, 106, 109, 128, 171, 173, 190–194, 255, 260, 295
<i>gammy legs (gam)</i> , 106, 292, 295	<i>lethal at scute (l'sc)</i> , 17, 30, 37, 41, 45, 50, 68, 69, 73, 271	<i>pannier (pnr)</i> , 41, 45, 151, 190–194, 234, 235, 242, 292, 295, 302
<i>Gap1</i> , 179–182	<i>lilliputian (lilli)</i> , 180, 289	<i>partner of inscuteable</i> , 271
<i>Geranylgeranyl transferase-1 (GGT1)</i> , 179, 180	<i>lines</i> , 295	<i>partner of numb</i> , 24, 264, 271
<i>giant (gt)</i> , 78	<i>liquid facets (lqf)</i> , 180, 223	<i>patched (ptc)</i> , 109, 111, 124, 125, 138–157, 177, 185–187, 194, 208, 231, 242, 285, 288, 301, 303
<i>glass</i> , 219, 220, 233, 254, 289, 305	<i>Lobe</i> , 207, 292	<i>pdm-1 (=nubbin)</i> , 11, 217, 297
<i>glass bottom boat (gbb)</i> , 143, 185, 189, 194, 289, 290	<i>lozenge (lz)</i> , 219, 220, 223, 233, 276	<i>pdm-2</i> , 11, 297
<i>glial cells missing</i> , 271	<i>m8 and other E(spl)-C genes</i> , 15, 17, 50, 61, 73, 127, 142, 164–169, 175, 177, 205–209, 219–223, 233, 264, 265, 271, 272, 278, 281, 300, 301, 303, 305	<i>period</i> , 262, 263, 302
<i>grain</i> , 112, 300	<i>many abnormal discs</i> , 290	<i>Phospholipase Cγ</i> , 179, 181, 182, 223, 303, 304
<i>grainyhead</i> , 217	<i>master of thickveins (mtv)</i> , 142, 148, 189, 288, 301	<i>phyllopod (phyl)</i> , 20, 182, 219, 220, 224, 271
<i>grim</i> , 228	<i>mastermind (mam)</i> , 169, 175, 273, 282	<i>PI3 kinase</i> , 303
<i>gritz</i> , 170, 180, 184, 218	<i>maverick</i> , 289	<i>pipsqueak</i> , 220, 300
<i>groucho (gro)</i> , 17, 49–52, 61, 71, 106–111, 135, 153, 155, 164, 173, 175, 223, 142, 254, 255, 265, 281, 291, 295, 298, 305	<i>Medea</i> , 109, 290	<i>pleiohomeotic (pho)</i> , 127, 135, 242
<i>gurken</i> , 170	<i>Merlin</i> , 289	<i>plexus</i> , 173, 174
<i>gustB</i> , 271	<i>Minute (multiple genes)</i> , 21, 29, 52, 56, 201	<i>poils aux pattes</i> , 135
<i>Gai</i> , 271	<i>miranda</i> , 24, 271	<i>pointed (pnt)</i> , 153, 169, 179, 181, 182, 194, 219, 220, 242
<i>H15</i> , 112, 114, 133, 296	<i>mirror (mirr)</i> , 186, 190–194, 203–208, 234, 236, 242, 296	<i>polychaetoid (pyd)</i> , 30, 71–75, 263, 283
	<i>misshapen</i> , 209, 293	<i>Polycomb (Pc)</i> , 107, 135, 148, 160, 242, 248

INDEX

451

- polycombeotic* (=Enhancer of zeste), 242
Polycomblake (Pcl), 65, 242
polyhomeotic, 107, 111, 122, 128, 149, 155, 288
porcupine (porc), 106, 242, 293
postbithorax (see *Ubx*), 87
Posterior sex combs (Psc), 242, 271
Presenilin (Psn), 53, 283, 295
prickle (pk), 131, 136, 209, 293, 300
proboscipedia (pb), 135, 239, 242
prospero (pros), 11, 24, 182, 219, 220, 224, 233, 254, 274
Protein Kinase A. (See *DC0*)
Protein Kinase C (PKC), 109, 263, 294
Protein Phosphatase 2A. (See *twins*)
Protein Tyrosine Phosphatase-ERK/Enhancer of Ras1 (PTP-ER), 179, 181, 304
puckered, 278
punt, 106, 109, 114, 115, 118, 129, 145, 185, 188, 190, 194, 229, 235, 289
radius incompletus, 177
Rap1, 179–181
Ras GTPase-activating protein (RasGAP), 181
Ras1, 29, 153, 169, 179–182, 194, 223, 228, 242, 254, 304
rasputin (rin), 181
reaper, 228
reduplicated, 123
retina aberrant in pattern (rap), 212, 223
RhoA, 209, 293
Rhodopsin (genes #1–#6), 197, 223, 224, 253, 254
rhomboid (rho), 141, 173–189, 194, 217, 223, 227, 303
roadkill, 289
rolled (rl=dMAPK), 173, 177, 180, 183, 185, 233
rotund (rn), 127
rotundRacGAP (=rotund), 29, 181, 182, 189
rough, 213, 215, 218–224, 228, 233, 234, 289, 305
Roughened (=Rap1), 181
rudimentary, 29
rugose, 223
runt, 264
sanpodo (spdo), 11, 29, 271
saxophone (sax), 143, 189, 289–291
scabrous (sca), 15, 30, 50, 55, 62, 75, 147, 157, 165, 215, 219, 223, 225–227, 233, 283, 289, 305
scalloped (sd), 142, 164, 171–173, 242, 265, 271, 296, 301, 302
schnurri (shn), 109, 188, 291, 292
scratch, 223, 274
screw, 289
Scruffy, 141
scute (sc), xiv, 17, 20, 30, 31, 37–75, 91, 113, 142, 161, 163, 191, 193, 223, 225, 245, 283, 292, 296, 301, 303
Scutoid, 278
semang, 181, 182, 223
senseless (sens), 50–52, 72, 220, 233, 271, 284, 302
Serrate (Ser), 15, 24, 25, 52, 55, 127, 135, 158–169, 173, 175, 203–209, 225, 242, 274, 296, 300, 301
seven in absentia (sina), 20, 182, 219, 220, 224, 271
sevenless (sev), 179, 180, 213–220, 227, 302, 303
seven-up (sup), 181, 215–224, 233
sex comb distal, 135
Sex comb extra (Sce), 242
Sex combs on midleg (Scm), 242
Sex combs reduced (Scr), 80, 112, 239, 242–248
shaggy (sgg), 109–118, 130, 132, 156, 157, 163, 190, 194, 205, 278, 294
shattered, 223
shaven (=dPax2), 28
shibire (shi), 26, 49, 52, 53, 59, 146, 175, 275, 284
shifted, 285
short gastrulation (sog), 185, 188, 303
shortsighted, 289, 305
shotgun (shg = dE-cadherin), 109
sine oculis (so), 205, 220, 228, 235, 242, 252–254, 261, 287, 292
singed (sn), 29, 39
single-minded (sim), 177, 262
skinhead, 169, 242, 292
sloppy paired, 84
smoothened (smo), 105, 109, 111, 128, 149–154, 185, 208, 229, 231, 286
snail (sna), 91, 264, 278
Son of sevenless, 179, 181, 182, 304
spalt, 30, 125, 140–143, 154, 155, 158, 174, 177, 185–187, 194, 205, 220, 224, 233, 245, 251, 252, 291, 292, 296, 301–303
spalt-related (salr), 141, 185, 186, 245, 301
spineless (ss), 29, 91, 127, 135, 205, 242, 249–254, 300
spiny legs (sple=prickle), 67, 131, 293
spitz (spi), 48, 52, 89, 91, 147, 169, 170, 174, 179–185, 194, 215–218, 227, 228, 242, 303, 304
split (see *Notch*), 15, 17, 50, 272, 281
split ends (spen), 181, 292
sprint, 181
sprouty (spry), 174, 179–185
Src42A, 181
Star, 29, 177–185, 217, 228, 303
starry night, 209, 293, 304
strabismus (=Van Gogh), 209, 293
strawberry notch, 135, 166
string, 11, 30, 44, 92, 223, 233, 271, 296, 302
Stubble, 29
sugarless (sgl), 106, 290, 293
sulfateless (sfl), 293
super sex combs (sxc), 242
supernumerary limb (slimb), 105, 109, 111, 115, 149, 154, 157, 164, 180, 242, 287, 294
Suppressor 2 of zeste, 271
Suppressor of deltex (Su(dx)), 272, 278
suppressor of forked (su(f)), 100, 119, 123, 135, 242
Suppressor of fused (Su(fu)), 109, 154, 286
Suppressor of Hairless (Su(H)), 9–25, 49–52, 135, 158, 164, 169, 171–175, 209, 219, 224, 255, 275, 284, 297
suppressor of Hairy wing (su(Hw)), 161
TACE, 258
TAF250, 254
tailless (tll), 223, 239
tam (=polychaetoid), 281, 283
tango (tgo), 29, 161, 242, 252, 263
target of poxn (tap), 258, 271
tartan (trn), 127
tartaruga (trt), 292
teashirt (tsh), 127, 134, 136, 166, 207, 242, 252, 295
tetraltera (tet), 242
thick veins (tkv), 106, 109, 114–118, 124, 125, 129–134, 141–148, 177, 185–189, 194, 229–235, 288–292, 301, 303
timeless, 263
tolkin, 185, 189
Toll-like receptor, 300, 301, 305
tolloid, 189
torso, 179, 304
tout-velu, 185
tramtrack (ttk), 11, 18, 19, 169, 182, 218, 220, 224, 242, 255, 259, 271, 275
tricornered, 29
trithorax (trx), 107, 242, 248
Tubulina α 1, 138, 154
Tufted, 278
tumorous head 1, 278
twin of eyegone (toe), 235
twin of eyeless (toy), 205, 235, 242, 253, 254
Twin of m4 (Tom), 73
twins, 11, 24, 109, 157, 179, 181, 275, 289, 294, 295
twist, 239, 254
two-faced (tfd), 242
UbcD1, 182
Ultrabithorax (Ubx), 78, 80, 87, 112, 237, 239, 242–253, 299, 305
ultraspiracle, 217, 220
u-shaped (ush), 45, 190–194, 292, 302
Van Gogh, 209, 293
vein (vn), 141, 153, 167–186, 205, 216, 227, 288, 289, 296, 302, 303, 305
ventral veinless (vvl), 141, 142, 171, 174, 177, 189, 263, 296, 303
vestigial (vg), 86, 89, 91, 139–142, 156–158, 164–173, 242, 245, 265, 292, 296, 301, 303
VP16 (herpes virus), 13, 51, 61, 254, 284
vrille, 289
white (w), 201
wingless (wlg), 15, 30, 55, 78, 79, 87–91, 104–129, 133–142, 146, 156–173, 189–194, 205, 230–236, 242, 245, 279, 289, 292, 295, 301, 302
yan, 179, 180–182, 194, 220, 259
yellow (y), 1, 17, 36, 39, 41, 43, 45, 67, 193, 201
 genetics. *See also* mutations; phenotypes
 analysis, xiv, 62, 202
 artifacts, xiv, xv
 background effects, 36, 38, 45, 69
 chimeric transgenes, 13, 18, 51, 68, 126, 147, 209, 216, 224, 284, 303
 complementation, 37
 constructs, constitutively active, xiii, 12, 51, 114, 124, 141, 145, 151, 170, 173, 190, 207, 216, 234
 constructs, dominant-negative, 169, 195, 216, 242
 constructs, inversion recombination, 43
 cosuppression, 298
 deletion analysis, 41
 developmental vs. physiological, 299
 dosage compensation, 71, 248
 dosage effects, 13, 21, 23, 29, 30, 31, 49, 52, 68, 69, 71–75, 113, 175, 208–211, 243, 246, 287, 297
 dosage screens, 68
 enhancer maps, 41, 239
 enhancer traps, xiii, 165, 219, 282, 296, 301

genetics (*contd.*)

epistasis, xiii, xiv, 48, 109, 160, 161, 175,
179, 183, 186, 188, 209, 271, 278, 287
epistasis, paradoxical, xiv
flp recombination, xiii
flp-out trick, xiii, 185
Gal4-UAS method, xiii
genome project, xi
gynandromorphs, 1–4, 36, 39, 52, 67, 77,
86, 91
haplo-insufficiency, 21, 29, 50, 52, 113,
160, 175
heat-shock promoters, xiii, 7, 69
history, xv, 12–15, 32, 37–43, 57
inhibition by RNAi, 271
intersexuality, 63, 72, 246
inversions, 298
LOF vs. GOF testing, definitions, xiii
molecular, 167
mosaic analysis, 9, 23, 33, 35, 39, 45, 52,
56, 69, 80, 85, 104, 114, 128, 151–155,
209, 213, 218, 302
mosaic analysis vs. *Gal4-UAS* method, 118
nomenclature, xiii
nonspecific effects, 249
penetrance vs. expressivity, 159
phenotypic rescue, 13, 18, 21, 47, 51, 71,
118, 151, 154, 158, 160, 164, 165, 173,
182, 186, 187, 188, 207, 216, 218, 223,
228, 231, 233, 235, 253, 274, 281, 283,
290, 291
pleiotropy, 302
ploidy chimeras, 55, 56
ploidy effects, 55, 56, 62
saturation of limiting factors, xiii, 12, 69
sex determination, 1, 30, 36, 49, 63, 72
somatic recombination, 33
techniques, xiii
temperature-dependence, 39
transpositions, 255, 298
transvection, 159
ubiquitous overexpression, 28, 45, 48, 68,
69, 75, 96, 109–119, 141, 145, 147,
182–186, 207, 215, 218, 233, 235, 246,
247, 276, 282
unequal crossing over, 134, 298
variegation, 3, 4, 248
vs. genomics, 254, 256
Gerhart, John, 255
Ghysen, Alain, xii
Gibson, Matt, 122
Gierer, Alfred, 184
Goldschmidt, Richard, 39, 73, 237, 299
Gómez-Skarmeta, José Luis, 41, 44
gradients
back-to-back, 89, 148, 209, 211
biphasic (spire-ramp), 158
bootstrapping, 153–55
cell-size independence, 92
centrifugal, 129
cone-shaped, 93, 94, 101, 103, 104, 127,
129, 131, 227
contour lines, 31, 94, 103, 128, 139
contour maps, 100
curved, 101, 104, 124, 126, 128
developmental capacity, 93
double, reciprocal, 78, 124, 147, 291, 304
embryo, 76, 84, 109, 113, 158
eye disc, 205, 209, 211, 215
heterochronic, 158, 209
leg disc, 111, 124, 129

leg segments, 80, 135
linear vs. exponential, 81, 83, 158, 301
merging, 156
mirror-symmetric, 89, 97, 145, 148, 163,
167, 209, 211
notum, 104, 190–193
nuclear import, 133
of gene expression, 127, 129, 135, 143, 177,
235
overlapping, 78, 101, 104, 124, 291, 304
parabolic, 128
parasegmental, 84, 89
peaks vs. valleys, 156
perception vs. reality, 125, 134, 143, 147,
158, 188–190, 291
proneural, 39, 163, 164
saddle-shaped (composite), 134
sawtooth, 80
seamless appearance, 153–156
segmental, 83, 84
shaping, 158
sliding, 156
slopes, 81, 92–94, 125, 147, 158, 205, 227,
291, 301
slopes, opposing, 78, 124, 147, 291, 304
smoothing, 147, 158
tent-shaped, 101, 167
theory, 81, 83, 92, 93, 124, 158, 209, 299
wing disc, 111, 138–146, 156–158, 186, 301
wing veins, 185, 188
Greenwood, Simon, 231, 234
growth
advantage, 201
anti-apoptosis factors, 118
asymmetric, 154
blastemic, 96, 123
cell-density independence, 94
cessation, 92, 94, 99, 122, 124, 155
compensatory, 89, 91
control, 86, 92, 124, 155
control by patterning system, 124, 134, 148
disc, 57, 85, 89, 92
disproportionate, 91, 123, 150, 155, 156,
252
distal, 100, 101, 103, 115, 133, 171
even vs. uneven, 33, 35, 92, 148, 158
extended period of, 92, 121, 155
factors, 92, 98, 115, 118–119, 124, 196, 283,
293
goal of, 91
gradients, 63
hyperplastic, 63, 80, 85, 92, 115–119, 124,
135, 143, 147, 157, 185
intercalary, 67, 93–95, 103, 123, 124, 133,
153–156
intrinsic limits, 92, 155
larval, 86
maintenance, 92, 122, 148
mitogens, 98, 118–119, 143
need for Dpp, 92, 118–119, 144, 148, 155
need for various pathways, 92
orthogonal, 118
potential, 93, 106, 124
rate, 4, 85, 91, 105, 133, 148, 150, 151, 153,
202, 305
region-specific, 87, 92, 133, 134, 153
role of nitric oxide, 92
stunting, 158, 164
timing, 1
vs. differentiation, 196
vs. patterning, 141, 158

vs. transdetermination, 85, 169, 249
wound-induced, 96, 98, 122
Gubb, David, 97
Hadorn, Ernst, 299
Haerry, Theodor, 143
Halder, Georg, 237, 252
Hanson, Thomas, 202
Hartenstein, Volker, 77
Heberlein, Ulrike, 229
Heitzler, Pascal, 52
histoblast nests, 1, 2, 73, 87, 299
history, xv
bristle pattern research, 32, 57
debate about AS-C, 37–43
debate about eye compartments,
202–203
debate about Fz-Dfz2 redundancy, 293
debate about Notch, 12–15
debate about SOP mitoses, 5
debate about sternopleura, 86
embryo segmentation, 76
embryology, 173
epochs and eras, 57, 86, 97–99, 105, 119,
202, 254
GDC Model, 92–96
genetics, 202, 254, 256
genetics, molecular, xii, xv, 97
ironies, 4, 33, 79, 103, 139, 156, 167, 246,
252, 256, 287
Morgan's team, xii, xiv, 1, 32, 33, 37, 86,
123, 298, 299
PC Model, 93–105, 113, 122–124, 154, 156
PC vs. Boundary Model, 103–105
prepatterning vs. positional information,
79–84, 251
signal transduction pathways, 105
studies of discs, xii, 76
utility of studying, 254
histotypes, 9, 72, 81, 85, 169, 189, 242, 243,
254
Holtfreter, Johannes, 304
homeosis, 84, 123, 160, 237–255. *See also*
genes: master; mutations: homeotic
amnesia, 249
antenna-to-leg, 80–85, 96, 129, 249–252,
299
context-dependence, 252
correlated with regeneration, 85, 246
correlated with tissue loss, 85
definition of, 80, 237
etiology, 85
eye-to-antenna, 169
general problem, 81, 237
halter-to-wing, 80, 87, 243, 246
inter-compartment, 87, 148, 149,
158–161
inter-disc, 84, 85, 171
inter-leg, 65, 80, 87, 243
inter-segmental, 243
intra-disc, 169
leg-to-wing, 115
notum-to-wing, 169, 302
of head, 141
paradoxical, 65
patchy, 81, 83
single-cell. *See* cell states: switching
vs. transdetermination, 85, 169, 237, 242,
249, 254, 302
wing-to-haltere, 151, 243
wing-to-notum, 169, 302

- homology
 antenna-leg, 81, 83, 249–252, 299
 bristle-scale, 67
 eye-wing, 203, 205
 inter-leg, 63, 65, 89
 shaft-socket, 23
 veins-bristle rows, 187
 wing-haltere, 89, 249
Huang, Françoise, 57
- imaginal discs. *See also* imaginal discs,
 particular
 adeipithelial cells, 87
 basal lamina, 87
 cell cycle. *See* mitosis
 cell death. *See* apoptosis; cell death
 co-culturing, 118
 compartments. *See* cell lineage;
 compartment boundaries
 conjoined, 98, 100, 123, 156
 culture, 84, 92, 94, 96, 169, 175, 203, 212,
 248
 cytonemes, 67, 125
 definition of, 1
 delamination, 87
 determination vs. differentiation, 86, 91
 diploidy, 86
 disc-specific markers, 86, 89, 91, 171
 dissociation-reaggregation, 65, 85, 90
 duplication vs. regeneration, 92–97, 100,
 103, 121–124, 139, 156, 169
 duplications, 86, 99, 115, 157
 embryonic origin, 1, 77, 85–91, 171
 epidermal cells, 86
 epidermal vesicles, 132, 149, 151, 153, 190
 epithelial folds, 2, 87, 124, 139, 245
 epithelial folds, extra, 115, 135
 epithelial puckering, 151
 epithelium, 46, 65, 69, 87, 197
 epithelium, columnar, 87, 121, 122, 139,
 233
 epithelium, pseudostratified, 87
 evagination, 1, 57, 65, 87, 89, 139, 174, 199
 extracellular matrix, 124, 174
 extracellular space, 124
 filopodia, 53, 65, 67, 87, 125, 174
 fusion, 123, 150, 151, 156
 geometry, 99, 121
 growth. *See* growth
 histology, 4, 86
 history of studies, xii, 76
 hollow sacs, 1, 87, 122
 hyperplasia, 85, 115, 117, 119, 135, 157,
 185
 identities, 86, 90, 149, 249, 254
 identities of compartments, 85, 89, 107,
 145, 148, 150, 153, 158–163, 173, 188,
 203, 248
 identities of subfields, 171, 240, 302
 identity codes, 84, 85, 240, 251, 254, 302
 insularity, 87
 invagination, 85, 87, 91, 99
 irradiation, 86, 95, 97, 99, 100, 106, 135,
 139
 maceration, 96
 mesoderm cells, 85–87
 mitosis, resumption of, 85
 mitotic arrest, 85
 mitotic orientations, 87, 133
 mitotic rates, 85, 87, 153, 299
 myoblasts, 87
- necrosis, 113
 neurons, 87
 numbers of cells, 85, 86, 169
 peripodial membrane, 87, 93, 97, 121–123,
 139, 205, 304
 planarity, 87
 prematurely metamorphosed, 133
 regeneration, 86, 92–96, 100, 103, 299
 regeneration, polarity of, 94, 95, 100, 103,
 304
 regeneration, types of, 123
 regenerative potential, 93–96, 100–105,
 123, 139
 rotation, 89, 199, 205, 207, 299
 size, 67, 85, 92, 245
 stalk, 87, 89, 99, 199, 234
 surgical fragmentation, 92, 94, 95, 99, 100,
 103, 121, 139, 169
 tissue removal, 95–100, 103
 tracheae, 86, 87, 139, 174
 trans-luminal extensions, 87
 trans-luminal interactions, 96, 122, 123,
 139, 212
 transplantation, 92, 94, 169, 175, 203, 212,
 248
 tumors, 85
 wound healing, 85, 96, 100, 103, 121, 122,
 156
- imaginal discs, particular, 2
 clypeolabral, 2, 77, 86, 199
 eye. *See* eye disc
 genital, xii, 1, 2, 4, 77, 87, 91, 123
 haltere, xii, 4, 77, 85, 86, 171, 239, 243, 245,
 299
 humeral, 2, 77, 87
 labial, 2, 4, 77, 86, 169, 199, 247
 leg. *See* leg disc
 wing. *See* wing disc
- Ingham, Philip, 79
- insects, xi, 67, 72
 cockroach, 93, 98, 119, 135, 300
 Drosophila. *See Drosophila*
 epidermis, 87
 grasshopper, 49, 129, 151, 300
 hemimetabola, 105, 133, 135
 hemiptera, 49, 59, 224
 holometabolous, xi
 honey bee, 223
 hymenoptera, 76, 223
 lepidoptera, 29, 31, 47, 61, 65, 67, 132, 299
 mosquito, 212
 other dipterans, 67, 69, 76, 86, 99, 193, 255
 paleoptera, 243
 vs. humans, 197
 vs. mammals, 13, 179, 297, 302
 vs. nematodes, xii, xiii, 1, 11, 50, 247
 vs. plants, 262
 vs. slime molds, 105, 151
 vs. vertebrates, xi, xiii, 86, 93, 151, 197,
 199, 224, 261, 297, 304, 305
 wasp, 302
- Internet databases, xii, xiii, 112, 205,
 257, 301
- Jan, Lily Yeh, 10
Jan, Yuh Nung, 10
- Karch, François, 305
Karlsson, Jane, 105
Kauffman, Stuart, 84, 249
Kirschner, Marc, 255
- larva, xi
 Bolwig's organ, 285
 brain, 92
 denticle belts, 79, 285
 development, 86, 87
 dimensions, 2
 discless, 86
 epidermis, 77, 86, 87, 99
 eye organ, 289
 fat body, 92
 growth, 86
 Keilin's organ, 99
 midgut, 77, 289, 291
 neurons, 99
 polyteny, 86
- Lawrence, Peter, 32, 84, 89, 101, 148
- Lebovitz, Richard, 212
- Lecuit, Thomas, 129, 141, 143
- leg
 anatomy, 99, 127, 131
 axes. *See under* axes
 branched, 99–103, 115, 123
 claws, 4, 75, 99, 103, 106, 115, 117, 118,
 127, 251, 252, 299
 clone stripes, 133
 cockroach, 93, 98, 119, 135, 300
 deformed, 106
 evolution, 132, 300
 feathery, xi
 femur-tibia detachment, 135
 fused 1st legs, 97
 fused segments, 80, 128, 135
 grasshopper, 129, 151, 300
 hemimetabolous insects, 105, 133, 135
 identity ("legness"), 240, 249, 254
 identity (vs. antenna), 83, 246, 249–254
 intersegmental membranes, 80, 300
 joints, 135, 136, 205, 299, 300
 joints, extra, 131, 135, 136
 pretarsus, 134, 151
 regeneration, 133, 135
 segmental gradients, 80, 83, 135, 300
 segmental identities, 129–135, 300
 segmentation, 80, 128, 131, 135–136, 300
 segmentation, leg vs. body, 136
 short, 65
 trochanter boundary, 132
 truncated, 118, 119, 129, 132
- leg disc
 antineural stripes, 128
 bipolar duality, 105, 106, 114
 border cells, 135
 compartments, 4, 63
 dispensable regions, 119
 distalization, 115–119, 129–134
 Dpp (vs. Wg) as a major mitogen, 118–119
 Dpp and Wg as morphogens, 111–113
 Dpp-Wg circuitry transition thresholds,
 117
 Dpp-Wg cooperation in distalization,
 115–118
 Dpp-Wg mutual antagonism, 113–115
 duplications, 115, 132
 endknob, 87, 100, 103, 114, 117, 131
 extra, 115
 fate map, 96, 99, 105, 106, 111, 128
 folds, 87, 133, 134, 136
 folds, extra, 115, 135
 gene expression patterns, 89, 109,
 111–117, 121, 126, 127, 131–135, 243,
 245, 251

- leg disc (*contd.*)
 geometry, 99, 105, 121, 128, 129, 137, 301
 growth control center, 119
 initiation, 77, 89, 91, 114, 117, 129, 132
 mitoses, region-specific, 133
 modes of morphogen transport, 124–125
 outgrowths, 100, 115–119, 124, 132
 outgrowths, converging vs. diverging, 119
 proximal-distal axis, 115–118, 129–135
 proximal-distal zonation, 127, 131–135
 proximal-vs.-distal cell affinities, 132
 quirks, 123, 132, 133
 regional markers, 113, 114, 115, 117, 129, 134
 role of ad epithelial cells, 87
 role of *Dll*, 129–132
 role of Hh-Dpp-Wg circuit, 105–119, 128–129
 routes of morphogen transport, 125–128
 spot, Dll-sensitive, 129
 spot, peripodial Hh, 121–123
 spot, quiescent, 92, 117, 135
 sternopleura, 86, 89, 99, 106, 118, 127, 299
 tip specification, 115–118
 topology (vs. body segment), 109
 upper medial quadrant, 97, 99, 101, 122, 123, 156
 vs. wing disc, 137, 170, 171
Lewis, Edward, 243, 244, 246, 298
ligands. *See also* gradients; morphogens
 affinity for receptor, 52, 124, 125, 165, 293
 anti-apoptosis, 118
 cell-surface, 53, 135, 167
 cis interactions, 52, 61, 73, 211
 cleavage from precursor, 48, 53, 126, 146, 181, 182, 217, 259, 285, 289
 cognate receptors, 9
 diffusible, 1, 46, 49, 53, 61, 89–91, 111, 121, 142, 145, 146, 150, 153, 169, 180, 181, 211, 215, 217, 225, 285, 289, 292
 diffusion range, 55, 89–92, 107, 111, 113, 117, 119, 124–125, 140, 145–158, 183–188, 215, 218, 227, 285–288, 304
 diffusion range, modulation of, 125, 126
 diffusion rate, 125, 143, 147, 183, 193, 215, 285, 286
 effective range, 125
 endocytosis, 27, 59, 124
 epitopes, 126
 exocytosis, 124
 extinction, 50
 gradients, 147
 homodimerization, 289
 ingestion, 175, 179, 213, 215
 membrane-bound, 53, 179, 272, 275, 280
 proteolysis, 158
 redundant, 24
 regulation by receptor, 166
 regulation of receptor, 125, 158, 166, 288, 292, 295
 release, 125
 short-range inducers vs. long-range morphogens, 101, 104, 107, 109, 115, 117, 138, 187, 234, 304
 tethering to lipid rafts, 125
 transcytosis, 27, 124
 unknown, 29, 53, 119, 127, 131, 133, 134, 223, 227, 293
Lindsley, Dan, xii
links. *See also* circuitry
 definition of, xiii
 fallacious, 143–148
 for bipolar duality, 114, 169, 302
 for cell memory, 248
 for computing SOPs, 48
 for creating boundaries, 107, 111, 145, 149
 for disc identity, 239, 243–252
 for disc initiation, 89–90
 for ensuring single SOPs, 47, 50–52
 for explaining regeneration, 121–123
 for eye's A-P axis, 229–235
 for eye's D-V axis, 205–211
 for making bristle patterns, 59, 75, 190–194, 278–284
 for making bristles, 11–20, 25, 271–275
 for making eyes, 205
 for making gradients, 142
 for making leg segments, 300
 for making legs, 113–119, 128–135
 for making ommatidia, 219–227, 305
 for making sensilla, 27, 276–277
 for making wing veins, 175, 186–187, 303
 for making wings, 158, 165–171, 301
 for rewiring other links, 253–255, 302
 for signal transduction, 109, 125, 137–148, 158, 181, 285–296
 for wing's A-P axis, 145, 156
 for wing's D-V axis, 156, 161–164
 inconsequential, 158
 wiring, *cis-trans*, 136, 246
logic. *See also* circuitry
 Boolean, xiii, 17, 25, 79, 113, 114, 117, 128, 130, 134, 157, 171, 172, 193, 213, 215, 219, 251, 252, 254, 289, 292, 295, 296, 299, 300
 disc development, 256
 double-negative, xiii, 47, 51, 78, 107, 187
 grammar, 20, 254, 300
 jigsaw-puzzle, 163, 219, 252, 254, 261, 300
 nucleosome, 239, 305
 of chemical reactions, 100
 promoter, 17, 18, 122, 254, 298
 subtractive, 59, 61, 128, 141, 163, 302
 syntax, xiii, 10, 18, 79
 Venn, 79, 112, 117, 133, 158, 166, 171–173, 251, 302
Ma, Chaoyong, 229
Maynard Smith, John, 32
mechanisms, 270. *See also* circuitry
 actomyosin motors, 26
 bootstrapping, 153, 155
 cell alignment, 151
 cell shaping, 23, 44
 clocks, intrinsic vs. extrinsic, 11, 215, 217
 clocks, oscillator, 297
 counting, 10, 11, 73, 297, 304
 dominoes, 11, 215
 error-correction, 73, 148
 gating, 10, 11, 21, 69, 233, 287
 inert decoy, 50, 68, 71, 72, 160–163, 180, 216, 260
 lateral inhibition, xiv, 39, 47, 49, 55, 59, 175, 184, 215, 224–227, 304
 licensing, 11, 44, 233, 254
 nucleosome displacement, 248
 quality control, 73
 ratcheting, 10, 11, 81, 121, 143, 147, 155, 217, 243, 244
 reaction-diffusion, 33, 69, 184, 225
 schedule, 11, 215
 servomechanisms, 153–155
 shuffling of zinc fingers, 20
 stripe-adding, 78, 87, 107, 131, 133, 134, 142, 145, 153–155, 159, 160, 164, 177, 208–209, 234, 302, 303
 stripe-splitting, 59, 61, 62, 78, 79, 128, 142, 163, 166
 time window, 10, 68, 71–74, 216, 246, 247, 299
 timing, 11, 53
 vesicle transport, 27, 124, 265
 weird, 87
Meinhardt, Hans, 100, 101, 184
Mentzel, Christian, 298
Merriam, John, 4
metamorphosis, xi, 76, 86, 87
metaplasia, 84
Micchelli, Craig, 173
microbeam irradiation, 76
microcautery, 76, 95, 97, 106
Milán, Marco, 173
mitosis
 arrest, 24, 44, 69, 85, 92, 117, 135, 151, 160, 234, 304
 asymmetric, 7, 11, 24
 asynchronous, 9
 cell cycle, 11, 24, 44, 49, 85, 100, 223, 233, 234, 265, 304
 licensing, 44, 233
 nuclear shifts, 304
 orientation, 3, 4, 7, 24, 87, 133
 quiescent spots, 44, 69, 92, 117, 135
 quiescent zones, 92, 151, 160, 233, 234, 304
 radiosensitivity, 41
 random vs. patterned, 92, 208, 233
 rate, 4, 81, 85, 87, 91, 151, 153, 202, 299
 regulators, 92
 spindle, 3, 24
 synchrony, 44, 85, 87, 208, 211, 215, 233, 234, 305
 syncytial, 79, 86
 timing, 174
 zonation in wing, 175
Mlodzik, Marek, 225, 231
models, 266–268
 active-cell vs. passive-cell, 125
 Bateson's toy, 99
 cellular automata, 235
 computer, 79, 224, 236, 303
 hybrid, 84, 101, 103, 158
 intransigence, 147
 mathematical, 79
 overturned, 13, 38, 39, 44, 48, 84, 87, 123, 134, 145, 147, 158, 185, 202, 211, 224, 247, 253
 resurrected, 13, 79, 115, 156, 224, 299
 robustness, 99
 utility, xiv, 32, 123
Modolell, Juan, 37, 57
Mollereau, Bertrand, 224
Morata, Gines, 89, 148
Morcillo, Patrick, 161
Morgan, Thomas Hunt, xi, 31, 193, 256, 298, 302
morphogenesis, xi, 23, 87, 124, 131, 134, 135, 148, 174, 304
morphogens. *See also* gradients; ligands;
 morphogens, particular; positional
 information
 active transport, 101, 124, 125
 as mitogens, 92, 118–119, 148
 as survival factors, 92, 118, 228

INDEX

455

- binding by lipids, 124
 binding by proteoglycans, 124
 channeling, 101, 124, 126
 circumferential, 101, 104
 constraints on usage, 158, 249
 constructs, membrane-tethered, 139, 145, 153, 157, 185, 285, 293
 definition of, 81, 138
 diffusion range. *See under* ligands
 dorsalizing vs. ventralizing, 104, 109, 111–113
 mistaken expression, 85
 modes of movement, 104, 124–125, 146
 passive diffusion, 124, 126, 130
 polarized movement, 125
 pumping, 129
 rate of transport, 125
 response modulation, 84, 125, 134, 158
 retrograde transport, 125
 role of actin, 125
 role of cell shape, 124
 role of dynamin, 125
 role of receptor density, 125, 158, 188
 spheres of influence, 106, 111, 124
 tagging with GFP, 147
 transcytosis, 27, 124, 146
 transport via cytonemes, 125, 146
 transport via lipid rafts, 125, 146
 morphogens, particular
 Bicoid, 77, 83
 Decapentaplegic, 89–91, 104–129, 133–137, 140–148, 153–158, 171, 177, 185–196, 229–234, 254
 Hedgehog, 84, 89, 90, 104–112, 117–129, 137–146, 150, 153, 177, 185–187, 196, 229–234, 254
 Spitz, 89, 91, 196, 215, 254
 tip (unknown), 83, 100, 103, 104, 122, 129, 251
 Wingless, 84, 89, 90, 104–129, 133–137, 142, 146, 156–158, 161, 171, 189–190, 196, 234, 254
 Wnt (unknown), 113, 132, 133, 136, 205, 231, 292, 293, 304
 Muller, H. J., 32, 37, 39
 mutations. *See also* phenotypes
 affecting bristle patterns, 194, 278–284
 affecting bristles, 271–275
 affecting bristles and sensilla, 276–277
 allelic series, 129
 allelic specificity, 20, 24, 37, 38, 39, 44, 45, 132, 284, 291
 antimorphs, xiii
 atavistic, 36, 63, 67, 135, 174, 243, 246
 breakpoints, 41, 43, 44, 129, 194, 195, 280
 cell-lethal, 63, 97, 98, 100
 deletions, 18, 23, 28, 35, 41, 43, 44, 48, 50, 51, 59, 69, 71, 134, 164, 185, 186
 dominant vs. recessive, xii, 129
 dominant-negative, 173, 234
 duplications, 23
 heterochronic, 299
 homeotic, 63, 65, 80, 83, 135, 169, 237, 240, 243, 246–249, 261, 300, 302
 hypomorphs, 7, 23, 37, 59, 73
 idiosyncratic, 52, 75, 87, 158, 288
 inversions, 41, 43, 44
 lethal, 87, 141
 lethal phase, 86
 lethal side effects, 80
 macromutations, 237
 maternal effect, 278
 missense, 15
 Morgan's quest for, 37
 neomorphs, xiii, 18, 87, 149, 271, 278, 284, 288, 302
 nomenclature, xii, 37
 nonsense, 44
 null vs. leaky, xii, 10, 21, 23, 75, 118, 138, 154, 157, 183
 null, compound, 37, 44, 69, 107, 114–119, 125, 132, 149, 153–157, 165, 188, 207, 215, 216, 218, 227, 231, 273, 275, 282, 291, 303
 null, utility of, 43, 44, 117, 118, 293
 P-element insertions, 49
 point, 41, 44, 298
 prepattern, Stern's quest for, 80, 252
 rearrangements, 186
 screens, 5, 18, 26, 37, 87, 141, 160, 305
 screens, dosage, 68
 screens, modifier, 12, 180
 temperature-sensitive, xiii, 15, 23, 26, 59, 63, 73, 121–123, 138, 139, 156, 169, 173, 182, 229, 235, 283
 X-ray induced, 37
 mysteries, 268–270
 Needham, Joseph, 301
 Nellen, Denise, 141, 143
 nervous system
 antigens, 208, 213, 215
 axon projections, 55, 97, 191–196
 cell lineage, 4, 11
 embryo, 49, 50, 52, 73, 149
 gene expression, 27
 genetics, 271, 278
 grasshopper, 49
 imaginal discs, 87
 lobes, antennal, 191
 lobes, optic, 141, 196, 198, 285, 292
 midline fates, 262
 mutation screens, 5
 neurons, 27, 173
 repressors, 20
 wiring, 5, 20, 27, 55, 99, 139, 191–196, 199, 228
 Neumann, Carl, 157
 neurogenesis
 adult, 31
 axon pathfinding, 20, 55, 99, 174, 191–96
 axons, retrograde transport, 125
 bristle. *See* bristles
 embryo, 24, 31, 166
 ganglion mother cells, 11, 24
 HLH genes, 72
 neural competence, 49
 neuroblasts, 7, 9, 11, 24, 49, 51, 52, 77, 191, 196, 217, 274, 297
 Nöthiger, Rolf, xii
 Nüsslein-Volhard, Christiane, 76
 Oberlander, Herbert, xii
 Occam's Razor, 35
 O'Farrell, Patrick, 124
 O'Keefe, David, 173
 ommatidia
 bristles, 30, 57, 199, 209, 218
 cell types, 197, 199, 208–211, 215, 223, 227, 228, 233
 chirality, 209–211
 cone cells, 208, 212, 215–219, 228
 firing center (at equator), 305
 founder cell (R8), 213–218, 227, 233
 lattice, 32, 201, 202, 208, 224, 227, 230
 mystery cells, 208, 211, 223
 number per eye, 197
 photoreceptors. *See* photoreceptors
 pigment cells, 209, 212, 216, 218, 228, 229
 polarity, 81, 198, 207, 203–211, 236, 293
 rate of creation, 208, 227
 rhabdomere trapezoids, 197, 209, 211
 role of Delta-Notch, 53, 211
 rotation, 131, 201, 208–211, 304
 spacing, 212, 304
 stages of development, 208, 211, 215, 217, 225, 227, 233
 Pan, Duoia, 252
 pattern formation. *See also* axes; boundaries; circuitry; morphogens; prepattern; positional information; rules
 alignment, 67, 148–153
 amphibian limbs, 93
 arthropods vs. vertebrates, 93
 Bateson's Rule, 99–101
 by balkanization, 131, 148, 190, 301, 302
 by chain reactions, 111, 156, 167, 215, 235, 297
 by determination waves, 211, 212, 235, 305
 by drawing lines, 97, 173, 179
 by elaboration, 63, 133, 302
 by intersecting lines, 35, 45, 89, 90, 101, 157, 234
 by invisible scaffolds, 156
 by iteration, 29, 74, 135, 145, 217, 300
 by painting sectors, 97
 by painting stripes, 61–62, 69, 78
 by physical forces, 33, 35, 135, 175, 189, 237
 by sequential induction, 139, 211, 215
 by signal relay, 139, 186
 by slicing a cylinder, 136
 by stratification, 87, 107, 131–134, 142, 145, 153–155, 159, 160, 164, 177, 208–211, 234, 302, 303
 by symmetric annealing, 136, 167, 174, 177
 by tessellation, 224
 by triangulation, 56, 59, 224, 305
 cell death, 87
 cell lineage, irrelevance of, 3
 cell-size independence, 92
 checkerboard, 50, 158
 community effect, 85
 continuity, maintenance of, 99, 101
 control of growth, 124, 134, 148
 David vs. Goliath power, 123
 development vs. regeneration, 94, 97, 123
 discontinuities, 93, 95, 105, 124, 154–156
 discs vs. embryo, 97
 disruption, 80
 distalization, 100, 115–119, 129–134, 157, 158, 166, 171
 duplication vs. regeneration, 92–97, 100, 103, 121–124, 139, 156, 169
 duplications, 86, 99, 105, 115, 154
 duplications, mirror-image, 89, 94–99, 103–106, 113, 118, 122, 128, 129, 148–165, 169–173, 275
 during growth, 86, 94, 133
 edge effects, 93–96, 103, 153, 305
 epimorphosis vs. morphallaxis, 96, 103, 123

- pattern formation (*contd.*)
 evolution, 86
 feather lattice, 224, 305
 fingerprints, 151, 199, 299
 general problem, xi
 generic tools, 179
 homeogenetic induction, 85
 hypertrophy. *See* growth: hyperplastic
 in a syncytium, 86
 intercalation, 93–96, 133, 153–156
 local vs. global, 21, 33, 50, 55, 56, 62, 68,
 79, 81, 92, 94, 128, 139, 173, 196, 211,
 212, 224, 235, 236, 254, 301
 molecular basis, 79
 noise, 201, 202, 228, 229
 number control, 136, 304
 organizers, 100, 129, 301
 out of phase, 84, 225, 227, 233
 precision, 31, 46, 62, 69, 86, 99, 151, 156,
 201, 228, 305
 principles, 270
 quirks, 86, 299, 305
 reconstitution, 67, 90, 156
 regeneration, 81, 86, 93–95, 100, 103, 123,
 156, 246, 299, 304
 repatterning, 67
 reprogramming, 63, 246
 robustness, 91
 scaffolds, 79, 80, 148
 short-range inducers, 101, 104, 107, 109,
 115, 117, 138, 187, 234, 304
 subpatterns, 20, 62, 154, 156
 top-down vs. bottom-up, 56
 topographic cues, 69
trans-boundary cooperation, 189
 triplications, 98, 99, 100, 119, 254
 vertebrate somites, 304
 vs. growth, 141, 158
 without positional information, 133
 patterns. *See also* anatomy; bristle patterns;
 phenotypes
 geometry, 31, 32, 56, 59, 93, 123, 160, 189,
 201, 211, 212, 304
 geometry, leg vs. wing, 99, 105, 128, 137,
 139, 301
 hoops, 135, 151
 ladders, 90, 189
 lattice, 32, 201, 202, 224, 227, 230, 305
 mammal coat color, 302
 orthogonal, 137, 189
 pigmentation, 32, 43, 75, 193
 Peifer, Mark, 305
 phenotypes
 Bateson's sports, 99
 bizarre, xii, 1, 30, 53, 63, 94, 98, 115, 117,
 119, 124, 143, 145, 153–155, 157, 203,
 237, 248, 252, 254, 265
 converging vs. diverging outgrowths, 98,
 100, 101, 103, 119
 deficient (but not duplicated), 106, 118,
 139, 169, 170
 discless, 87
 disc-specific, 87
 duplication-deficient, 97, 106, 113, 139,
 155, 169
 etiologies, 80, 96, 119, 123, 128, 131, 136,
 153, 154, 157, 163, 249, 262, 271
 hyperplasia, 63, 80, 115–119, 124, 135, 143,
 147, 157, 185
 Janus, 106, 113, 118, 128, 129, 153, 159,
 163, 169
 leakiness, 21
 mirror-image, 63, 89, 95–100, 105, 106,
 113, 118, 122, 128, 129, 148–165,
 169–173, 275
 paradoxical similarity of LOF and GOF,
 160, 163, 171, 286
 phenocopies, 80, 99, 185, 189, 237
 quantitative spectrum, 156
 segment-polarity, 136
 sensitive periods, 26, 63, 98, 123, 135, 170,
 175, 182, 189, 216, 229, 237, 252, 284
 syndromes, 49, 80, 99, 131, 136, 149, 164,
 165, 182
 triplications, 98, 99, 100, 119, 254
 photoreceptors
 anatomy, 197, 199
 axon projections, 196, 198
 developmental sequence, 208–215, 218,
 227, 233
 gene expression, 220
 identity code, 219, 224, 233
 inner vs. outer, 197, 199, 233
 markers, cell-type specific, 215, 218, 220
 nuclear shifts, 304
 R1–R6, extra or missing, 216, 218, 220, 224
 R3–vs.-R4 determination, 209–211
 R7 equivalence group, 182, 215
 R7, extra or missing, 180, 213–218, 220,
 224
 R8 equivalence group, 225
 R8 spacing, 55, 62, 225
 R8, extra or missing, 223
 R8, need for *atonal*, 28, 72, 74, 217, 220
 R8, similarity to SOP, 225
 rhodopsin subtypes, 197, 223, 224, 253,
 254
 vs. bristles, patterning of, 57, 225
 Plunkett, Charles, 39
 Poodry, Clifton, xii, 39
 positional information. *See also* axes;
 boundaries; gradients; morphogens
 abdominal segments, 84, 141
 absurd aspects, 158
 area codes, 81, 85, 191
 azimuths, 106, 124
 clockface metaphor, 103, 155
 coordinate systems, 56, 79, 81, 83, 96, 103,
 105, 193
 coordinate systems, bipolar, 106
 coordinate systems, Cartesian, 90, 93, 101,
 105, 157–158
 coordinate systems, polar, 93, 95, 97, 101,
 105, 124, 126, 128
 coordinate systems, tripolar, 101, 106
 coordinate systems, warped, 122
 coordinates, polar, 103
 crowded coordinates, 99, 103, 105, 122
 definition of, 81, 84
 down-the-slope constraint, 93
 emission vs. reception, 148, 151
 French Flag metaphor, 81, 84, 139, 299
 graininess, 83, 92, 158, 299
 individuation, 84, 89, 145, 148, 163
 interpretation, 81, 83, 84, 209, 251
 interpretation modes, 83, 84, 89, 167, 249,
 251, 300
 interpretation, minor role of, 158, 301
 intrasegmental, 83, 135
 PI-prepattern hybrid, 84, 158
 positional values, 81, 83, 84, 93, 96, 99,
 248, 251
 positional values, misleading idea of, 158,
 301
 precision, 81, 124, 158
 recording, 81, 83, 84
 reference lines, 87, 89, 95, 109, 151, 188
 reference points, 55, 59, 90, 101, 157, 234
 singularities, 93
 specification, 81, 83, 89, 251
 specified vs. determined states, 90, 111
 stages, 81
 thresholds, 84, 104, 109, 113–117, 126–131,
 138–147, 154–158, 183–193. *See also*
under circuitry; prepattern
 thresholds, setting, 167
 thresholds, sharpening, 291
 universality, 81, 83, 84, 96, 202
 vs. prepattern, 83, 79–84
 wiring of genome, 41, 83, 84
 zonation, 78, 84, 107, 125, 127, 131,
 138–143, 163, 188–193, 252, 301
 zonation, orthogonal, 142, 158
 Posthlethwait, John, xii
 prepattern, xiv, 33, 43, 68, 301
 absurd aspects, 80, 83
 antenna vs. leg, 83, 251
 competence, 35, 39, 47, 83
 definition of, 33
 embryo segmentation, 79, 84
 evolution, 36
 factors, 45, 47, 69, 73, 75, 190, 193, 229, 305
 genes. *See under* genes
 gradients, 56
 hypothesis, 33, 35, 39, 79–83, 251
 landscape, 62, 69, 193
 macrochaetes, 35, 68, 190–193
 mutants, 80, 252
 nodes, 33, 79, 80
 overlapping, 83
 pair-rule stripes, 78, 79
 PI-prepattern hybrid, 84, 158
 proneural clusters, 55, 68
 proneural vs. antineural, 164, 195
 reaction-diffusion, 33, 83
 saga, 80
 sex comb, 80, 135
 singularities, 33, 35, 36, 80, 83, 84, 158, 301
 singularities, *cis*-enhancers for, 35, 92
 singularities, cryptic, 36, 41, 43, 68, 135
 thresholds, 83. *See also under* circuitry;
 positional information
 universality, implausible, 80–83
 vindication, 79, 190, 251, 299
 vs. positional information, 79–84
 programming. *See under* computer
 metaphor
 protein domains. *See also* protein domains,
 particular
 alterations, 72, 300
 dimerization, 15, 17, 161, 216, 248, 280,
 283
 docking, 68, 158, 300
 domain-swapping experiments, 179, 260
 idiosyncratic, 28
 interchangeability, 257
 masking vs. unmasking, 15, 21, 261, 263,
 273, 274
 overlapping, 15, 21
 propellers, 249, 265
 reference sources, 257
 repeats, definition of, 257
 repeats, extreme number, 259

- scaffolding, 257, 263, 293
- self-defeating, 288
- size range, 257
- steric effects, 72
- protein domains, particular, 257–265
 - 14–3–3, 179, 258
 - activator vs. repressor. *See under* gene regulation (activators or repressors)
 - ADAM, 258
 - ankyrin, 12, 13, 180, 258
 - arm, 258
 - basic, 17, 23, 161
 - bHLH, 17, 28, 29, 41, 48, 61, 74, 91, 177, 217, 225, 239, 242, 249, 258, 259, 272
 - BTB, 18–20, 135, 259
 - bZip, 180
 - COE, 186, 259
 - cut, 259
 - DEF, 180, 181, 259
 - DEJL, 181, 259
 - DNA-binding, 17–23, 28, 61, 68, 71, 85, 107, 141, 148, 161, 163, 171–174, 190, 218, 223, 239, 242, 257–265, 275, 277, 282, 288–291, 295, 303
 - EF hand, 295
 - EGF-like, 15, 52, 165, 170, 180, 181, 259
 - EH, 26, 259
 - Ets, 181, 182, 259
 - F, 180, 260
 - glycosylation sites, 15, 289, 292
 - GUK, 260
 - helix-turn-helix, 260, 263, 291
 - HLH, 39, 49, 50, 68, 71–73, 161, 260, 297
 - HMG, 180, 242, 260, 295
 - homeo, 11, 24, 107, 129, 135, 158, 161, 186, 190, 191, 203, 213, 217, 223, 235, 239, 242, 249–252, 260–263
 - Hox hexapeptide, 254, 260, 261
 - Ig-like, 170, 180, 181, 261, 263
 - KH, 180
 - kinase, 179
 - leucine zipper, 261
 - LID, 161
 - LIM, 135, 136, 158, 161, 261
 - LNG, 261
 - MADS, 174, 186, 239, 261, 290
 - NES, 262
 - NLS, 12, 13, 15, 20, 180, 262
 - opa, 141, 180, 262
 - Orange, 61, 71
 - paired, 252, 262
 - PAS, 29, 177, 249, 262
 - PDZ, 180, 263, 292
 - PEST, 12, 263
 - PH, 180, 181, 263
 - POU, 167, 217, 263, 297
 - PRD, 264
 - PTB, 24, 180, 264
 - PxDLSx(K/H), 71, 264
 - RAM23, 13
 - RNA-Binding, 181, 264
 - runt, 264
 - SH2, 180, 181, 264
 - SH3, 180, 181, 264
 - signal, 265
 - Sox, 45, 265
 - sterol-sensing, 125, 285
 - TALE, 254
 - TEA, 171, 265
 - transmembrane, 13, 15, 261, 285
 - VP16, 13, 51, 61, 284
 - WD, 24, 249, 265
 - WD40, 180
 - WRPW, 17, 51, 61, 71, 255, 265
 - zinc finger, 18–20, 48, 50, 52, 91, 107, 127, 132, 134, 136, 141, 180, 186, 190, 217, 223, 224, 239, 242, 252, 265
 - proteins. *See also* genes, particular; proteins, common; proteins, modification of
 - adaptors, 24, 109, 179, 180, 254, 263, 264, 294, 304
 - adhesive, 134, 150, 151, 153, 173, 174, 177, 261, 299
 - binding affinities, 259, 264, 265, 291, 294, 295
 - bipolar, 19, 107, 255, 288
 - bridging, 41, 45, 160, 161, 191, 279, 284, 287, 294
 - caspases, 228, 262
 - catalysts, 13
 - cellomics, 298
 - chimeric, 13, 18, 51, 68, 126, 147, 209, 216, 224, 284, 288, 303
 - chromatin-remodeling, 17, 71, 111, 207, 239, 247–249, 264, 277, 282, 295, 300
 - competitive binding, 17, 18, 68, 72, 79, 84, 161, 170, 215, 278, 291, 295
 - conformational changes in, 26, 258, 261, 264, 286, 290
 - constant shape vs. variable sequence, 260, 263, 264
 - convertases, 53
 - cooperativity, xiv, 79, 84, 261, 263, 265, 290, 300
 - cytoskeletal, 180
 - cytoskeletal regulators, 181
 - deacetylases, 293
 - dehydrogenases, 293
 - dimerization, 17, 49, 79
 - DNA-binding. *See under* protein domains
 - geranyl transferases, 180
 - GFP-tagged, 126
 - glypicans, 290, 293
 - GTP exchange agents, 180, 181
 - GTPases, 26, 180, 181, 275, 293
 - GTP-binding, 26
 - heterodimers, 12, 15, 17, 21, 49, 50, 68, 71–75, 133, 171, 172, 190, 193, 251, 252, 258–264, 272, 276–280, 284, 290, 303
 - homodimers, 15, 17, 71, 72, 146, 181, 258–263, 272, 273, 280, 286, 289
 - huge vs. tiny, xi, 174, 180, 259
 - immunological detection, 13, 27, 41, 43, 53, 126, 147, 303
 - immunological tracking, 175
 - isoelectric point (pI), high, 21
 - isoforms, 18, 19, 181, 182, 222–224, 239, 247, 258, 273–275, 281–284, 287, 294
 - isoforms, extreme variety of, 191, 261
 - kinase inhibitors, 11
 - kinases, 24, 180, 213, 263, 286, 287, 293, 294
 - ligands. *See* ligands
 - lipases, 181, 304
 - metabolic enzymes, 29, 85, 302
 - mimicry, 68
 - multi-protein, 254
 - multi-protein complexes, xiv, 11, 41, 182, 191, 224, 247, 248, 252, 261, 265, 271, 279, 280–289, 294–296
 - multi-protein machines, 300
 - neuronal, 191
 - nomenclature, xii
 - nuclear import, 9–11, 15, 20, 21, 131, 133, 171, 172, 251, 258, 286–295
 - oligmers, 258
 - oligomers, 181, 259, 262, 273, 275, 290
 - phosphatases, 11, 24, 157, 180, 181, 275, 289, 294, 304
 - polyadenylases, 100
 - proteases, 15, 53, 180, 189, 228, 258, 265, 289
 - proteoglycans, 55
 - proteolysis, 19, 20, 105, 133, 180, 182, 218, 224, 263, 271, 280, 294. *See also under* receptors
 - proteolysis, proteasome-dependent, 12, 107, 111, 262, 263, 271, 287, 288
 - receptors. *See* receptors
 - RNA-binding, 24, 181, 264
 - saturation, 9
 - scaffolding, 179, 180, 191, 258, 260, 283, 287, 294
 - schizophrenic, 255
 - secreted, 55, 90, 91, 105, 106, 111, 145, 146, 153, 165, 170, 182, 225, 227, 265, 285, 289, 292
 - self-cleaving, 146, 285
 - self-defeating, 259, 261, 290
 - sequestering, 9, 12, 15, 50, 68, 71, 72, 161, 167, 180
 - shedddases, 53, 258
 - size range, 257
 - stoichiometry, 13, 21, 61, 73, 163, 165, 171, 175, 286, 287, 291, 295, 298, 300, 303
 - sulphotransferases, 293
 - synthesis, 29
 - targeting, 20
 - tethering, 9, 12, 15, 24, 165, 286, 289
 - tetramers, 160
 - transcription factors, 18, 41, 48–52, 79, 105, 111, 132–136, 141, 143, 148, 156, 158, 163, 171, 180, 181, 186, 190, 213–224, 233, 239, 247–249, 254, 258–265, 272–293, 297, 300. *See also under* gene regulation
 - transmembrane, 9, 15, 179, 180, 182, 191, 213, 259, 261, 272, 274, 275, 279–294
 - turnover rates, 126, 147, 286, 287, 295
 - two-hybrid assays, 21, 55
 - two-hybrid screens, xiii, 24, 160
 - ubiquitin ligase adaptors, 180, 260, 287, 294, 296
 - ubiquitin ligases, 182, 265, 272, 273, 282, 296
 - ubiquitous. *See* genes: ubiquitously expressed
 - uncleavable constructs, 13, 287
 - weird, 21, 179, 213
 - proteins, common
 - actin, 125, 174
 - cadherins, 90, 92, 153, 191, 258, 295, 304
 - clathrin, 26, 124, 146
 - collagen, 174
 - connectin, 149
 - cyclins, 29, 44, 49, 233, 258, 260, 280
 - dynammin, 26, 124
 - importins, 258
 - insulin, 92
 - integrins, 160, 173, 174, 177
 - kinesin, 11, 286
 - laminin, 174
 - myosin, 11

- proteins, common (*contd.*)
 neurexins, 191
 neuroglian, 149
 spectrins, 180
 tropomodulin, 11
 ubiquitin, 180
proteins, modification of, 21
 by acetylation, 248, 279, 288, 295
 by acylation, 285
 by autophosphorylation, 290
 by autophroteolysis, 285
 by cholesterol adducts, 125, 146, 285
 by cleavage, 9, 12–15, 53, 107, 111, 126, 146, 181, 182, 213, 217, 259, 265, 274, 285–289
 by deacetylation, 17, 248, 249, 275, 276, 281
 by dephosphorylation, 275, 294, 304
 by geranylation, 180
 by glycosylation, 15, 124, 146, 165, 261, 292
 by hyperphosphorylation, 294
 by phosphorylation, 9, 13, 15, 24, 107, 111, 126, 145, 180–183, 218, 235, 260, 263, 273, 286–296, 300, 303
 by reshaping, 26, 258, 261, 264, 286, 290
 by ubiquitination, 180, 182, 263, 280, 287, 294
proteins, particular. *See* genes, particular
- Rauskolb, Cordelia, 173
Ready, Donald, 202, 211, 212, 224
receptors
 affinity for ligand, 52, 124, 125, 165, 293
 auto-repression, 261
 capping, 211
 cassettes, 179
 cis interactions, 164, 211
 cleavage of precursor, 15, 213, 274
 constitutively active, 12, 114, 124, 141, 145, 151, 170, 173, 190, 207, 216, 234
 co-receptors, 105, 109, 217, 286, 290, 293
 density, 125, 188
 density, effects of, 147, 158
 dimerization, 9, 181, 293
 dominant-negative, 147, 169, 173, 183, 195, 216, 242
 endocytosis, 27, 59, 124, 146, 182, 285
 gradients, 147
 heterodimers, 289
 hypersensitized, 52, 189, 190
 hyposensitized, 143, 189, 190
 interchangeability, 216, 293
 ligand alternation, 165
 ligand-induced cleavage, 9, 12, 13, 15, 53
 maturation in Golgi, 15, 165, 274
 occupancy levels, 81
 olfactory, 191
 oligomerization, 9, 52, 261, 289
 phosphorylation, 181
 protein complexes, 179, 180, 273, 282, 286, 289, 293
 proteolysis, 12, 13, 15, 124, 182, 286
 recycling, 124
 regulation by ligand, 125, 146, 158, 166, 288, 292, 295
 regulation of ligand, 166
 serine-threonine kinases, 290
 trans-ingestion, 175
 tyrosine kinases, 170, 179, 182, 213, 231, 259, 264, 290, 303
 unknown, 55, 134
 with multiple ligands, 170
Reh, Thomas, 217
Reinitz, John, 79
Renfranz, Patricia, 225
Rhyu, Michelle, 5
RNA
 antisense, 303
 binding, 264
 clocks, 297
 computation, 73
 domains, 73, 272, 279
 heteroduplexes, 73
 localization, 73, 76, 84
 maternal, 76
 processing, 24, 73, 79
 splicing, 18, 19
 translation, 73
 turnover, 73, 100
 untranslated portion, 48, 73
Roegiers, Fabrice, 53
Romani, Susana, 43
Rubin, Gerald, 225, 252
rules, xi, xii, 270, 300. *See also* cell instructions
 about axon wiring, 55, 191–196, 199
 about bracts, 29
 about bristle patterns, 31, 68, 229, 230
 about bristles, 20, 55
 about cell autonomy, 47
 about cell lineage, 1, 18
 about cell size, 55, 56
 about cellular automata, 236
 about disc identity, 251, 252, 305
 about distalization, 115, 119, 157, 158
 about eye's D-V axis, 203, 205, 209
 about gene regulation, 18, 91, 104, 115, 171–173, 248, 251, 254
 about growth vs. differentiation, 59, 118
 about inhibitory fields, 55, 57, 59
 about interfaces, 148, 154, 155
 about ommatidia, 215, 227
 about regeneration, 93, 94, 95, 96, 97, 100, 103, 156
 about regulatory hierarchies, 136
 about tissue continuity, 94, 254
 about transdetermination, 84
 about trespassing, 132
 about Turing-like models, 69
 about wing veins, 187
 Bateson's Rule, 99, 100, 101, 103, 153
 Distalization Rule, 93
 Dpp-Wg Intersection Rule, 157
 Posterior Prevalence Rule, 248
 Proximity-vs.-Pedigree Rule, 4, 5
 Reciprocity Rule, 92, 94, 95, 96, 122, 156
 Shortest Intercalation Rule, 93, 95, 101, 154, 156
 Venn Overlap Rule, 172, 251
Sánchez-Herrero, Ernesto, 246
Schneiderman, Howard, xii, 32
Schubiger, Gerold, 122
Schultz, Jack, 38
science
 ad hoc assumptions, 99, 100, 103, 122, 131
 artifacts, xiv, xv, 48, 57, 107, 144, 147, 279
 big vs. little, 256
 cleverness, 31, 51, 97, 100, 143, 224, 239, 246
 conventional wisdom, 246
 correlation without causation, 4, 119, 149, 157, 234. *See also* uncoupling
 counterintuitive facts, 35, 160, 163
 debates. *See* history
 deductions, 12, 35, 37, 39, 43, 67, 83, 91, 124, 131, 170, 251, 298
 delusions, semantic, 247
 dialectic, 12, 187
 disappointments, 33
 discoveries, xi, 2, 4, 5, 35, 37, 40, 44, 49, 53, 85, 86, 90, 105, 121, 122, 125, 132, 149, 158, 165, 202, 208, 224, 256, 298
 disproofs, 38, 39, 44, 48, 158, 185, 202, 211, 224, 229
 dogmas, 53, 57, 96, 97, 246
 dramatics, 21, 75, 85, 134, 135, 143, 165, 237
 enigmas, 268–270
 epiphanies, 270
 heresies, 15, 41, 57, 96, 119, 149, 246, 285, 292
 heuristics, 123, 136, 266, 302
 hypotheses, 266–268
 illusions, xv, 23, 68, 72, 134, 166
 insights, xi, xv, 33, 56, 79, 83, 97, 139, 157, 246, 254, 256, 300
 messy data, 43, 47, 183, 287
 metaphors, 266–268
 mistakes, xiv, 12, 38, 43, 147, 156
 models, 266–268
 mysteries, 268–270
 myths, 147, 202
 negative results, 147
 paradigms, xv, 43, 44, 79, 83, 84, 103, 202, 245
 paradoxes, 10, 27, 52, 55, 56, 80, 93–96, 113, 128, 160, 169, 183, 231, 246, 268–270, 282, 286
 predictions, 10, 15, 33, 41, 44, 47, 49, 56, 79, 85, 97, 153, 205, 213, 218, 265
 proofs, 1, 12, 20, 50, 61, 67, 86, 90, 113, 115, 118, 139, 155, 157, 202, 204, 212, 217, 231, 246, 297
 prophecies, 43, 79, 84, 97, 190, 301
 reasoning by analogy, 137, 148, 161, 163, 203
 reasoning from first principles, xii, 31, 35, 60, 101, 125, 158, 201, 213, 216
 red herrings, 18, 109, 134
 reductionism, 299, 302
 riddles, 268–270
 scenarios, 266–268
 skepticism, 12, 100, 114, 187, 202
 surprises, xii, 18, 33, 37, 41, 43, 44, 52, 68, 69, 77, 87, 91, 97, 99, 105, 131, 153, 180, 183, 209, 216–218, 243, 252, 260, 282, 287, 303–305
 systems analysis. *See* uncoupling
 unnatural side-effects, 25, 124
self-assembly. *See also* boundaries, creation of; emergent properties; mechanisms; pattern formation; positional information
 general problem, xi
 of bristle rows, 65, 67, 299
 of concentric rings, 134, 224, 304
 of dynamin collars, 26
 of multi-protein complexes, 248, 249, 303
 of ommatidia, 212, 213, 215, 227
 of stripes, 150, 151, 173, 174

- sensilla
 campaniform, 28, 63, 65, 99, 131, 185, 276, 299, 304
 chordotonal, 27, 29, 74, 112
 external, 27
 extra, 73
 halter, 246
 identity genes, 27, 75
 larval, 9, 24, 27
 nests on legs, 304
 olfactory, 27–29, 75, 191, 199, 246, 276
 role of AS-C, 44
 shifts, 63, 131
 stretch receptors, 28
 trichoid, 28, 304
 vs. bristles, 27–28
 vs. bristles on wing vein L3, 187
 wing, 174
 wing radius, 18
- sensory organ precursor (SOP). *See also* bristles
 ablation, 49
 asynchrony, 55, 59, 62
 computer, 72
 delamination, 65
 eccentric, 43, 47
 filopodia, 53, 65, 67, 299
 heterochronic pairs, 53, 57
 initiation, 21, 37, 43–55, 59, 61, 68, 71–73, 163, 229, 278–284
 markers, 156, 282, 284
 mitoses, 5, 7, 41, 49, 59, 92, 229
 movements, 61, 63, 65, 67
 patterns, 39, 59, 61, 94, 139, 163, 193
 pre-SOP state, 47, 53
 regression, 53, 71
 repulsion, 65, 67
 selection, 45–74, 229, 304
 sequence, 41, 57, 59, 67, 133
 vs. PNC identity, 48, 51
 vs. R8p photoreceptor, 225
- Serebrovsky, A. S., 37
- Serrano, Nuria, 124
- Shearn, Allen, xii
- signaling pathways. *See also* signaling pathways, particular
 antagonistic, 74, 114–117, 121, 167, 179, 234, 235
 anti-mitogenic, 92
 artificial switching, 171
 as networks, 179, 300, 303
 assays for activity of, 126, 183, 218
 branched, 181, 293
 comparisons, xii, 27, 92, 105, 109, 157, 179–182, 297, 300, 303
 context-dependence, 21, 179, 181, 303
 control of AS-C, 71
 cross-talk, 15, 50, 52, 129, 136, 167, 180, 274, 279, 284, 290, 294, 300, 303
 mitogenic, 92
 PCP (planar cell polarity), 131
 shared components, 15, 109, 157, 180, 181, 275
 unorthodox variations, 11, 109, 173, 289, 292
- signaling pathways, particular
 Boss-Sevenless, 179, 181, 213, 215, 218, 220, 233, 303
 dActivin, 92
 Decapentaplegic, 105, 109, 124, 132, 141, 157, 167, 173, 177–180, 185–190, 194, 231, 235, 286, 289–292
 EGFR, 29, 48, 52, 74, 92, 107, 153, 169, 170, 174, 177–189, 194, 216–219, 227–229, 233, 235, 242
 Hedgehog, 92, 105, 109–113, 149, 154, 157, 177, 185–187, 194, 208, 231, 235, 242, 285–289
 insulin receptor, 92
 JAK-STAT, 92, 205, 303
 JNK, 118, 263
 Notch, 9–27, 49–55, 68, 69, 73–75, 92, 135, 159–169, 173–180, 188, 194, 203–211, 218, 219, 223–229, 235, 242, 263, 272–275, 279–284, 303
 PCP (planar cell polarity), 293
 Ras-MAPK, 92, 179, 216, 218, 224, 263, 304
 RTK, xiv, 170, 179–182, 218, 231, 258, 264, 265, 303
 Wingless, 15, 52, 92, 105, 109, 132, 136, 156, 157, 167, 169, 181, 182, 189–190, 194, 205, 242, 245, 279, 285–288, 292–296
- Simpson, Pat, 52
- Skeath, James, 41
- Spemann, Hans, 36
- Spencer, Susan, 227
- Stern, Curt, xv, 32–43, 49, 56, 57, 75, 79–83, 86, 163, 164, 190, 246, 251, 252, 256, 298–302
- Strigini, Maura, 137
- Struhl, Gary, 157, 211, 224, 231, 234
- Strutt, David, 231
- Sturtevant, Alfred Henry, 1, 2, 4, 31, 38, 39, 86, 91, 134, 298, 299
- Swammerdam, Jan, 76
- Thomas, John, 173
- Tokunaga, Chiyoko, 80, 83, 252
- Tomlinson, Andrew, 211, 212, 224
- topology
 disc-exoskeleton, 89, 99, 139, 199
 embryo-larva, 77, 89
 eye-wing, 203
 gene-anatomy, xi, 20, 31, 41, 45, 239, 242, 297, 298, 301
 gene-cell type, 83
 larva-adult, 2
 leg disc vs. body segment, 89, 109, 114
 leg segment vs. body segment, 136
 leg-antenna, 83, 199, 251, 299
 leg-wing, 137
 neuro-sensory, 5, 191
 space-time, 41, 43
 wound healing, 96
- transdetermination, 84–86, 96, 123, 169, 242, 249, 254, 302
- Turing, Alan, 33
- typeface formats, xiii, xiv
- uncoupling. *See also* circuitry
 of border from P compartment, 125, 151
 of cell size from body size, 55, 56
 of chemical reactions, 73
 of early vs. late roles of Dpp in wing, 188
 of growth from differentiation, 196
 of growth from patterning, 141, 158
 of growth in adjacent compartments, 92, 301
 of identity from affinity, 173
 of identity from boundaries, 154
 of identity from signaling, 149, 161
 of individuation from segmentation, 84, 299
 of larval from adult development, 86
 of ligand binding from signaling, 285
 of ligand transport from signaling, 125
 of optic stalk from eye furrow, 234
 of pedigrees from patterning, 3, 4
 of sensilla from veins, 185, 186
 of signaling from polarity, 205
 of veins from crossveins, 185, 189
 of veins from one another, 185, 186
- Ursprung, Heinrich, xii
- Waddington, C. H., 32, 224, 299, 300, 304
- Weatherbee, Scott, 245
- Weinstein, Alexander, 37
- Weismann, August, 76
- Weiss, Paul, 299, 302
- White, Richard, 212
- Whiting, Anna, 302
- Wieschaus, Eric, 76
- Wigglesworth, Vincent, 32, 49, 57, 59, 224
- Wilkins, Adam, 97
- wing
 airfoil, 136, 167, 174
 alula, 186
 anatomy, 139, 159, 177
 axes. *See under* axes
 blade, 49, 55, 87, 105, 153, 157, 173, 174, 185, 189, 190
 blade vs. hinge identity, 139, 158, 172, 301, 302
 butterfly, 31, 299
 corrugation, 174
 duplications, 123, 157
 evolution, 86
 expansion, 174
 extra, 141
 geometry, 137, 189
 growth, 29
 hairs, 87, 159, 189, 205
 hinge, 132, 139, 141, 172, 190, 240, 296, 301
 hinge, overgrowth of, 158
 identity (“wingness”), 171, 240, 249, 254
 margin. *See wing margin*
 missing, 137, 140, 151, 159, 160, 167, 303
 moth, 61, 65, 132
 notches, 157, 164, 165
 sensilla, 185
 shape, 164
 size, 29
 small, 140, 147, 151–154, 164, 185
 symmetry, A/P, 188
 transalar adhesivity, 174
 transalar lumen, 174
 veins. *See wing veins*
- wing disc
 advantages (vs. other discs), 93, 105
 bipolar duality, 114, 167–173, 302
 compartments, 4, 87
 distalization, 157, 171
 duplications, 157
 evagination, 174
 extra, 170
 fate map, 94, 139, 156, 193, 301
 folds, 87, 126, 139
 gene expression patterns, 89, 111, 141, 142, 169, 173, 177, 193, 245

wing disc (<i>contd.</i>) geometry, 137, 139, 160, 301 growth, 29 initiation, 77, 89, 91, 171 margin. <i>See</i> wing margin margin syndrome, 164, 165 mitoses, region-specific, 92 nomenclature, xiii outgrowths, 148, 153, 155, 157 outgrowths, multiple, 157 spot, unique distal, 157 spot, <i>vg</i> -on (in notum), 158 veins. <i>See</i> wing veins vs. leg disc, 137, 170, 171 wing vs. notum portion, 87, 167–173, 190–191, 193	vs. blade, 141, 173 vs. haltere capitellum, 245	initiation vs. fine-tuning, 177 interveins, widening of, 185 irregular, 188 L1. <i>See</i> wing margin L2 and L5 (Dpp-dependent), 177, 185–188 L2 sprouting bristles, 187 L3 and L4 (Hh-dependent), 177, 185–186 L3 proneural stripe and sensilla, 185 lateral inhibition, 175, 188 markers, 189 missing, 182, 183, 185–188 mitotic zones, 175 nomenclature, 177, 189 pattern in disc vs. adult wing, 94, 139, 193 patterning, 153–156, 173–191 pigmentation, 174 proveins, 175, 177 regulation by Delta-Notch, 53, 175–177, 188 regulation by Dpp, 177, 185, 188 regulation by EGFR, 177–185, 188 sharpening, 184 straightening, 173, 177 vein vs. intervein identities. <i>See under</i> cell states vs. bristles, patterning, 175, 187 vs. interveins, 174 vs. mesectoderm stripes, 179 vs. paraveins, 174 widening, 175, 182, 188 widening at tips, 12, 175 widths, 167, 173, 177 Wolff, Tanya, 211 Wolpert, Lewis, 32, 79, 80, 81, 83, 84, 93, 248, 249, 251, 299
wing margin asymmetry of, 159, 160, 164 at the eye equator (<i>sic!</i>), 203 bracts, 28 bristle rows, 31, 65, 67, 159, 189 bristles, 27, 48, 139, 159, 167, 277, 279, 282, 302 cell affinities in, 173 cell types in, 174 creation of, 159, 160, 173, 302 ectopic, 96, 159–161, 164, 165 gene expression in, 27, 48, 141, 146, 159, 163–167, 177, 183, 301, 303 gene regulation in, 161, 164, 171, 179, 295, 296 geometry, 137, 159 growth control by, 153, 157 missing, 284, 302 mitotic quiescence, 92 mutations affecting, 160 nomenclature, 153, 154, 155 tip vs. remainder, 157 vein properties of, 139, 183, 189	wing pouch asymmetry vs. symmetry, 167, 301 circuitry, 163, 166 dorsal edge, 128 extra, 157, 158, 170 gene expression in, 92, 141, 159, 171, 174, 177, 301 gene regulation in, 129, 148, 173, 177, 245, 288, 292, 296, 301 gradients, 142, 146 growth, 164 homeosis, 240 initiation, 87, 167, 170, 171 morphogens, 140, 142, 146, 156 overgrowth, 157, 164, 165 response to Dpp, 147 response to Notch, 164, 167 size, 139, 142	
wing veins annealing, 137, 174, 175, 177, 245 asymmetry, 174 atavistic, 174 branching, 173 circuitry (vs. tracheae), 174 confluent lawns, 183, 185, 186, 188 corrugations, 160 cross-veins, 177, 185, 188–189 determination, 188 displacements, 185, 186 extra, 173, 174, 182–188, 303 formula, 139, 154 function, 174 fusion, 153, 173, 185 gene expression in, 177, 183, 186–189 gene regulation in, 177 inducers vs. suppressors, 183, 186, 187 initiation, 182, 183		Zecca, Myriam, 137, 157 Zimm, Georgianna, xii