

Contents

<i>Preface to the second edition</i>	page xv
<i>Preface to the first edition</i>	xix
1 Regional specification in animal development	1
Why are we interested in embryos?	2
Homology and universality	3
The developmental hierarchy	4
2 The concepts of experimental embryology	9
Normal development	9
The fate map	10
Growth and stem cells	16
Forms of developmental commitment	18
The hierarchy of commitment	19
Lineage	20
Regulation and mosaicism	21
Acquisition of commitment	25
The embryonic field	25
Cytoplasmic determinants	26
Induction	27
Homeosis and the epigenetic coding	30
Glossary	31
Theoretical embryology	34
Cell states	34
Dynamical systems theory	35
The state space	37
A model for cellular specification	40
Gradient models for embryonic induction and regulation	43
Diffusion of a morphogen	43
The local source-dispersed sink (LSDS) model	45

Symmetry breaking processes	52
Double gradient models	53
Thresholds and memory	57
DNA methylation	59
Homeogenetic induction	60
Repeating patterns	61
Reaction-diffusion models	61
Mechanical instabilities	64
A clock model	65
4 Hierarchies of developmental decisions	67
<i>Xenopus</i> and other amphibians	67
Normal development	68
Molecular markers	73
Fate maps	75
Regionalization within the egg	80
The dorsoventral polarization	81
Regional organization during cleavage and blastula stages	85
States of commitment during cleavage	85
States of commitment in the blastula	87
Early inductive interactions	93
Dorsalization	96
Mechanism of mesoderm induction	98
The organizer	101
Specification of the anteroposterior pattern	104
Neural induction	106
Regional specificity of neural induction	107
Later events	110
Somitogenesis	110
The endoderm	111
Summary of regional specification in the early amphibian embryo	111
Sea urchins	112
Normal development	112
Molecular markers	115
Fate map	117
Regional organization	118
Unfertilized egg	118
Blastomere isolation and fusion	120
Morula	121
Micromeres	123
Vegetalization	124
Oral-aboral axis	125
Sea urchins and amphibians	125

5 Development with a small cell number	128
Molluscs and other spirally cleaving forms	129
Normal development and fate map	129
Other species and annelids	133
Role of the egg cytoplasm	136
Regional organization	137
Egg cytoplasm	137
Lobe removal	138
Blastomere ablation and isolation	140
Determination of the D lineage in equally cleaving forms	141
Segmentation in the leech	142
Ascidians	146
Normal development	146
Fate map	150
Regional organization	151
Determination of the muscle lineage	152
Other possible determinants	156
<i>Caenorhabditis elegans</i>	157
Normal development	158
Developmental genetics	160
Regional organization	163
Cytoplasmic localization	163
Laser ablation	164
Induction of the pharynx	165
General remarks on the mosaic embryos	165
An invariant cell lineage	166
A visible regionalization of the fertilized egg cytoplasm	167
Mosaic behaviour of defect embryos and isolated blastomeres	167
Cytoplasmic transfer	168
6 Models for Man: the mouse and the chick	171
The mouse	171
Normal development of the mouse	172
Fashionable genes	176
Fate map	178
Chimaerism and mosaicism	181
Specification of early blastomeres	182
Isolated blastomeres and giant embryos	182
Specification of the ICM and trophectoderm	183
Nuclear transplantation and imprinting	185
Later developmental decisions	187
Formation of primitive endoderm	187
Mural and polar trophectoderm	187
Visceral and parietal endoderm	188

Egg cylinder ectoderm	188
Embryonic stem cells and teratocarcinoma	189
ES cells	189
Teratocarcinoma	191
Transgenic mice	192
How typical is the mouse?	194
The chick	195
Normal development	196
Fate map	200
Regional organization	201
AP polarity and fragmentation of the blastoderm	201
Induction	205
Segmentation	209
A common program for vertebrate development?	211
 7 The breakthrough	 213
Introduction to insects	214
Normal development	215
Fate map	218
Cellular commitment	219
Pole plasm	220
<i>Drosophila</i> developmental genetics	221
Identification of relevant genes	222
Types of mutation	224
Mosaic analysis	225
Cloning of genes	227
Overview of the developmental program of <i>Drosophila</i>	229
The dorsoventral pattern	230
Maternal control	231
Zygotic control	234
Lessons from the dorsoventral system	235
The anteroposterior system	236
Maternal information: the anterior system	236
Maternal information: the posterior system	237
Maternal information: the terminal system	239
The gap genes	240
The pair-rule system	243
Regulation of pair-rule gene expression	246
The segment polarity genes	248
Homeotic selector genes	254
The anteroposterior body pattern	258
Results on other species	261
Descriptive embryology	261
Experimental studies	262

What <i>Drosophila</i> has taught us	265
<i>Drosophila</i> gene table	266
8 What does it all mean?	278
Learning from <i>Drosophila</i>	279
Appendix: How to write a program for development	282
Nomenclature	282
The program	284
Posterior and dorsal regionalization	286
Gastrulation	288
Dorsoventral interpretation	288
The growth zone engine	289
Anteroposterior specification	291
The body plan complete	295
<i>References</i>	297
<i>Index</i>	322