

Contents

Part I Discovery and Origins

1	Discovery	3
	Zwischenstrang	5
	A Brief Overview of the Past 120 Years	6
	1890–1950s	6
	1960s–1970s	9
	1980s to the 21st Century	9
	Neural Crest and Germ-Layer Theory	12
	Germ-Layer Theory	14
	Multiple Tissues from Single Layers	15
	Heads and Tails	16
	Secondary Neurulation and Tail Buds	17
	Induction of Tail Buds	18
	Neural Crest as the Fourth Germ Layer	19
	Neural Crest as Inhibitor	20
	Notes	21
2	Embryological Origins and the Identification of Neural Crest Cells	23
	Neural Crest	23
	Before Neurulation	23
	Establishing the Epidermal–Neural Border	25
	NCC Markers and Specification of the NC	27
	HNK-1 and <i>Pax7</i>	28
	<i>Snail-2</i> , <i>Bmp4</i> , and Cadherins	29
	Sox Genes	31
	Wnt genes	34
	Specification of Ectoderm as Neural or Epidermal	38
	NC Induction	39
	Bmps, Wnts, and Fgfs	39
	<i>Xenopus</i>	40

Chicken Embryos	42
A Role for Notch in NCC Induction	42
A Role for Bmps in NCC Induction and Beyond	46
Zic3 and Zic5	47
Msx Genes and Specification of NCCs	49
Establishing Cranial and Trunk Neural Crest	51
Chicken Embryos	52
Mouse Embryos	53
Ectoderm from the Most Rostral Neural Tube	53
Rostrocaudal Patterning of CNC	54
Hox Genes	54
A Role for Mesoderm	56
The Midbrain–Hindbrain Boundary	57
Dlx Genes and Dorsoventral Patterning of CNC	58
Notes	58
3 Delamination, Migration, and Potential	63
Delamination	63
Cellular Changes Driving Delamination	66
Cadherins	68
Extracellular Spaces and Delamination	70
Migration	71
Pathways of CNCC Migration	71
Pathways of TNCC Migration	73
Migration into Dorsal Fins and Tails	76
Molecular Control of NCC Migration	78
Extracellular Matrices, Cell Surface Ligands, and Receptors	78
Permitting Migration	79
Fibronectin	80
Proteoglycan Complexes	81
Neural Crest Cells Contribute to Extracellular Matrices to Permit Migration	82
Thrombospondins	82
Tyrosine Kinases Receptors (Trk)	84
Ephrins and Eph Receptors	84
Inhibiting Migration	84
Components of ECMs	84
Guiding Migrating NCCs	85
Barriers and Components of ECMs	85
The Environment at the Final Destination	86
Endothelins	89
Semaphorins, Delamination, and Migration	90
Subpopulations of NCCs	92
Restricted Premigratory and Early Migrating Populations of TNCCs	94

Restriction During Migration	97
Restriction Along the Neural Axis	97
Differentiation	99
Differentiation of Bipotential Cells	110
A Role for Growth Factors	110
Dedifferentiate and Redifferentiate	111
Summary	112
Notes	113
4 Evolutionary Origins	117
Precursors of the Neural Crest	118
Cephalochordates	122
Genes and Gene Networks in Cephalochordates	125
AmphiSnail1	126
Hox genes: <i>AmphiHox1–AmphiHox12</i>	127
AmphiDll	128
AmphiOtx	129
AmphiBmp	130
AmphiPax	130
Retinoic Acid and Retinoic Acid Receptors	131
Urochordates–Ascidians	134
Nervous System and Notochord	135
Pigment Cells	136
Calcitonin	136
Bipotentiality and Conditional Specification	137
Genetic Control of Ascidian Neural Development	137
Bmps	138
Snail and Hnf3	138
Pax Genes	138
Fossil Chordates	139
Burgess Shale	139
Chengjiang Formation	140
The First Vertebrates	141
The Pharyngeal Skeleton	141
The Origin of Cartilage	142
Comparative Genomics and Bioinformatics	146
Molecular Fingerprinting: Genetic Labeling/Selection and GeneChip	149
Microarray Technology	149
Jawless Vertebrates and the Origin of Jaws	149
Jaws from Gill Arches?	150
Notes	153
Part II Neural-Crest Derivatives	
5 Pigment Cells (Chromatophores)	159
Types of Chromatophores	160

Melanosomes	162
Lampreys	163
Urodele and Anuran Amphibians	163
Patterns of Pigmentation	164
Larval-to-Adult Patterns	165
Teleost Fish	167
Migration and Cell Fate	168
Larval Patterns	169
Genes and Cell Lines	170
Birds	172
Patterning Feather Tracts	173
Non-Avian Reptiles	173
Mammals	174
Pattern Formation	174
Neurocristopathies	175
Notes	176
6 Neuronal Cells and Nervous Systems	179
The Neural Crest, Neurons, and Nervous Systems	180
The Peripheral Nervous System—Spinal and Cranial Ganglia	181
Placodal Ectoderm	183
Placodal Markers and Specification of Placodal Ectoderm	189
The Panplacodal Domain	191
Induction of Individual Placodes	192
The Autonomic Nervous System	193
Schwann Cells	195
Glial Cells	195
Vagal and Sacral Neural Crest	197
Rohon–Béard Neurons	197
Apoptosis Removes R–B Neurons	198
Neural Crest Origin and Relationships to Other Neurons	198
Genetic Control of R–B Neurons	199
Notes	200
7 Cartilage Cells and Skeletal Systems	203
Pharyngeal Skeletons of Hagfish	205
Pharyngeal Skeletons of Lamprey	208
Cartilages	208
Vitamin A	213
Amphibian Craniofacial Skeletons	213
Extirpating and Transplanting Amphibian Neural Crest	214
Epithelial–Mesenchymal Interaction Required to Initiate	
Chondrogenesis	217
Cascades of Interactions in Amphibian Craniofacial Development	218
Labeling Amphibian CNCCs	221
Timing of Migration	223

Mapping CNCCs in Fish	227
Elasmobranchs	227
Teleosts	228
Zebrafish Mutants and Pharyngeal Arch Development	228
Distalless (<i>Dlx</i>) and the First and Second Pharyngeal Arches	228
Chameleon (<i>Con</i>) and the Caudal Pharyngeal Arches	229
Chinless (<i>Chn</i>) and the Absence of NCC from all Pharyngeal Arches	229
Ninja and the Growth of Pharyngeal Arch Cartilages	229
Skeletogenic NCCs in Reptiles	230
CNCCs	230
TNCCs	231
Avian CNCCs	231
³ H-thymidine Labeling	231
Quail/Chicken Chimeras	232
The Chondrogenic CNC	232
Cell Lineages in CNCCs	233
CNCCs and Muscle Patterns	237
Mapping the Mouse CNC	238
Notes	244
8 Teeth and Hearts: The Odontogenic and Cardiac Neural Crests	247
Teeth	247
The Odontogenic Neural Crest	248
Teeth but not Cartilage from Trunk NCCs	250
Cartilage from TNCCs?	252
Origination of Dentine and Bone	253
Hearts	255
Indirect Effects of Cranial NCCs on Heart Function	256
Direct Effects of Cranial NCCs on Heart Function	256
The Avian Cardiac Neural Crest	257
Cardiac Cartilages	260
Cardiac Neural Crest in Fish and Amphibians	261
Cardiac Neural Crest in Mammals	261
Cardiac Defects	262
Notes	264

Part III Abnormal Development and the Neural Crest

9 Neurocristopathies	269
Antiquity	269
Syndromology and Neural Tube Defects	269
The Utility of the Germ-Layer Theory	271
Types of Neurocristopathies	273
CHARGE Syndrome	276

PAX6 and CHD7	276
Neuroblastomas	278
The Neoplastic State	278
Diagnosis	279
RaLP	279
Model Systems	280
von Recklinghausen Neurofibromatosis	280
Involvement of Non-Neural-Crest Cells	282
John Merrick—the ‘Elephant Man’	282
Animal Models and Mutations	283
APUDomas	284
Hirschsprung Disease	286
DiGeorge Syndrome	288
Genetics	289
Genes Involved	289
Notes	291
10 NCC Development Revisited in the Context of Birth Defects	295
Susceptible Stages of Neural Crest Development	298
Defective Migration	299
Defective Proliferation	300
Enhanced Cell Death	300
Defective Induction	301
Vitamin A, Craniofacial Defects, and the Neural Crest	302
Direct Action In Vivo	302
Craniofacial Defects	305
Mechanisms of Action	308
Indirect Effects	309
Evolutionary Origins of Sensitivity to Retinoic Acid	309
Defects Following Disruption of the <i>Hox</i> Code	310
Hoxa1	310
Hoxa2	311
Hoxa1, Hoxa2, and Hoxb1	311
Mutations and Birth Defects	312
Looptail	312
Spotch	312
Regulation	314
Sources of Cells	316
Completeness of Regulation	316
Pharyngeal-Arch Regulation	317
Dorsal Root Ganglion Regulation	317
Regulation of Cardiac Neural Crest	319
Placodal Regulation from the Cardiac Neural Crest?	320
Neural Crest Cells as Stem Cells	321
Bi-, Tri-, and Multipotential NCCs	321

What is a Stem Cell? 322

NCCs as Stem Cells 323

Notes 325

Common Names of Species Discussed 329

Species (with Common Names) Arranged by Major Groups 333

References 339

Index 387

The Neural Crest and Neural Crest Cells in Vertebrate
Development and Evolution

Hall, B.K.

2009, XXII, 402 p. 149 illus., 16 illus. in color., Hardcover

ISBN: 978-0-387-09845-6