

Prologue The Rationalist Philosophers

All I Know is that I Know Nothing

The Benefits of Having an Immortal Soul

What Does All This Philosophy Stuff have to do with this Book?

CHAPTER 1 The Metazoans' Dilemma: Cell Differentiation and Neural Induction

1.1. Metazoans Evolved the Ability to Produce Cells with Very Different Functions

I. Preformationism Offered an Easy but Wrong Solution, While Epigenesis Seemed Incomprehensible

II. The Rediscovery of Genes Set the Stage for Understanding Development

III. Gene Expression Directs Cell Differentiation

Researchers at Work: Do Differentiating Cells Dispose of Unused Genes?

1.2. Scientists Domesticated a Simple Worm to Address the Questions of Cell Differentiation

I. Mitotic Lineage Guides Cell Differentiation in Worms

BOX 1.1 Kerfuffles in Language: "Cell fate" and "commitment"

II. Many Embryos, Including All Vertebrates, Display "Self-Regulation"

III. Experimental Embryology Revealed Inductive Processes Underlying Self-Regulation

1.3 A Region of the Vertebrate Embryo Seems to "Organize" Development

Researchers at Work: The Dorsal Lip of the Blastopore Can Organize a New Individual

I. Long Abandoned, the Organizer Was Uncovered through Molecular Biological Techniques

II. What Organizes the Organizer?

III. In Insects, Epidermal Cells Compete to Become Neuroblasts

The Cutting Edge: Tracing the pathway to the human organizer.

Visual Summary

CHAPTER 2 Coordinating Fates: Development of a Body Pattern

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Box 2.1. A Step Too Far

RESEARCHERS AT WORK: Two Heads Are Not Better Than One

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I. Some Mutations in Drosophila Transform Body Parts Whole

II. Hox Genes Are Crucial for Vertebrate Development, Too

III. Homeobox gene Otx2 specifies the vertebrate forebrain and midbrain

BOX 2.3 Kerfuffles in Language: "Segmentation"

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I. Several Signals Designate the Caudal End of the Body and Nervous System

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RESEARCHERS AT WORK: What Notochord Factor Induces the Floor Plate and Motor Neurons?

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The Cutting Edge: Brain Organoids

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II. The Developing Brain Generates Neurons at a Tremendous Rate

III. Shortly after Division, Neural Cells Diverge to Become Neurons or Glia

RESEARCHERS AT WORK: Labeling of Dividing Cells Disputes the Idea That Lineage Determines Fate
III. The Cerebellum AND Cerebral Cortex Form in Layers

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I. We Can Label Newly Synthesized DNA to Determine the Birthdates of Cells

II. Newborn Cells Shiny Up Glial Poles

RESEARCHERS AT WORK: The Cortex Develops in an Inside-Out Manner

III. A Few Brain Regions Display Continuing Neurogenesis throughout Life

BOX 3.1 THE CONTROVERSY OF NEUROGENESIS IN ADULTHOOD

3.3 Neural Crest and Cerebellum

I. Neural Crest Cells Migrate to Positions throughout the Body

II. Cell Adhesion Molecules Attract and Repel Migrating Cells

III. Cerebellar Granule Cells Parachute Down from Above

RESEARCHERS AT WORK Weaver Neurons Fail to Grasp Glial Fibers

The Cutting Edge: Profiling Gene Expression to Probe Brain Development

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4.1 The Differentiation of Neurons and Glia

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Box 4.1. Transgenics, Knockouts, and Knockins

II. Several Factors Influence Whether a Cell Will Become a Neuron or a Glia

4.2 Differentiation in Spinal Cord and the Periphery

I. The Molecular Differentiation of Motor Neurons Is Orderly

II. Neural Crest Cells Are Affected by Their Migration and Destination

RESEARCHERS AT WORK: Neural Crest Cells Adopt New Fates after Transplantation

RESEARCHERS AT WORK: Targets Can Regulate the Neurotransmitter Phenotype of Afferents

4.3 Evolutionary consequences of increased plasticity

I. The Fate of a Cortical Neuron Is Influenced Both before and after Migration

RESEARCHERS AT WORK: Cortical Neuron Fate Is Specified after the S Phase

II. Later Events in Development Are More Evolutionarily Labile

The Cutting Edge: Artificial Selection for Larger Forebrains

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5.1 Axonal Growth Cones Crawl Toward their Targets

I. Ramón y Cajal Described Growth Cones and Discerned Their Significance

II. In Vitro Approaches Reveal Principles of Axonal Growth and Adhesion

RESEARCHERS AT WORK: Getting a Grip: The Role of Adhesion in Axonal Growth

III. Guidance Cues May Be Attractive to One Type of Growth Cone and Repulsive to Others

5.2 Surrounding Cells Provide Guidance Cues

I. Families of Receptors Offer a Multitude of Guidance Cues

II. Pioneer Neurons and Guidepost Cells Establish Pathways for Later Axons

III. Many Axonal Growth Cones Have to Deal with Crossing the Midline

RESEARCHERS AT WORK: What Makes the Floor Plate so Attractive?

5.3 Major Projection Pathways "Read" the Environment

I. Motor Neuronal Axons Must Find the Correct Target Muscles

RESEARCHERS AT WORK: Can You Navigate Your Way Home?

II. The Axons of Retinal Ganglion Cells Must Reach the Midbrain

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The Cutting Edge: Identifying Callosal Axonal Growth Cones

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Researchers at Work: Presynaptic and Postsynaptic Receptors Trigger Synaptic Development

I. Neuromuscular Junctions Illustrate That Synapse Formation Is a Dance for Two (or More)

II. Motor Neuronal Agrin Promotes the Aggregation of Acetylcholine Receptors

III. Neuregulins Boost Local ACHR Expression in Muscle and Maintain Terminal Schwann Cells

IIII. Once Formed, the NMJ Leaves an Imprint in the Extracellular Matrix

Researchers at Work: Neuromuscular Junctions Leave a Residue in the Basal Lamina

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II. Myelination Extends into Adulthood to Hasten Neuronal Communication

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RESEARCHERS AT WORK: ADDING TO THE PERIPHERY PREVENTS APOPTOSIS OF MOTOR NEURONS

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 - II. Hormones Direct Sexual Differentiation of the Vertebrate Body and Behavior
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 - II. Long-Term Potentiation (LTP) CONFIRMS the Existence of Hebbian Synapses
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