

Contents

To the Reader	v
Introductory Note	xvii
Part I The Source of “Folly” and the Reason for Confessions	1
1. I am an Inconspicuous and Unattractive Creature Painted with Lipstick	3
2. They Say That I Resemble a Sausage	7
3. The Cell Is My Castle and Prison But I May Swim and Dance like an Odalisque in a Harem	8
4. The Striptease Show — How I Dress and Undress at Every Cell Division	11
5. I Have Created My Own Private World Full of Tricks, Back Door Exits and Novel Solutions — I am an Untamed Innovator	16
6. My Origins Were Humble — The Antithetical Nature of Matter Left a Mark on My Construction	19
7. My Split Personality — The Source of “Folly”	22
8. The Reason for Confessions	26
9. I Have Been Abused and Covered With Insults	28
10. The Wisdom of the Foolish	31
11. Scientific Concepts Are Prone to Change Throughout Time — The Nature of Science Demands that	36

Previous Ideas be Superseded, as New Technologies Allow a Deeper Insight into Matter	
12. What Seems Ludicrous at a Given Time Turns Out to be the Correct Explanation Several Years Later. The Gene was Considered to Consist of Protein, But Is Now Known to be a Ribbon of DNA	39
13. In the Last 20 Years the Number of Human Genes was Reduced from 200,000 to 32,000, and This Figure Remains Uncertain	41
14. The Models of Chromosomes Have Varied Drastically with Time	43
References	48
Sources of Illustrations	51
Part II Who Cares for Gravity	53
15. The Chromosome in Its Organization and Activity Follows Its Own Path — It Does Not Obey Gravity, Randomness, Selection or Magnetism	55
16. Definition of Gravity — Newton's Laws Are Good for Planets and Apples	57
17. What Is a Force — The Four Fundamental Forces	59
18. Newton's Laws Do Not Apply in Quantum Mechanics	61
19. Not All Bodies Fall When Unsupported	63
20. The Ascent of Sap in Trees-Another Unexplained Phenomenon	64
21. An Unknown Process Decides Which Cells Are Going to Grow in the Direction of Gravity and Which Are Going to Counteract It	67
22. Physicists Construct Antigravity Devices that Oblige Frogs and Plants to Float	71
23. Atoms Hide Many Properties that May Disclose the Mechanisms Behind Living Processes — Liquid Helium Can Build a Fountain Ejecting Itself Out of a Flask	73

24. Levitation in Metals — What Was Impossible Became Possible	75
25. Animals, like Plants, Have Created Devices that Counteract Gravity	77
26. In Giraffes the Distance between the Heart and the Head Is Over Two Meters	79
27. No Chromosome Obeys Newton's Laws — In Their Movements Chromosomes Bypass Gravity	82
28. Chromosomes Move in All Directions of the Mariner's Compass	84
29. It Is the Programmed Pattern of the Organism that Decides the Direction of Movement	86
30. The Devices Used by the Chromosome Which Result in Particular Movements	87
31. Chromosomes Move Inside the Nucleus, like Goldfish in an Aquarium, without the Use of Spindle Fibers	88
32. The Chromosome's Autonomy Takes Many Forms — The Chromosome Ends May Take Over the Function of Active Mobility on the Spindle	91
33. Chromosomes Inherited from the Father May Be Sent to a Different Compartment than Those Inherited from the Mother	93
34. How to Move Equally Well without Guiding Asters and Centrosomes	94
35. DNA Replication Already Disregarded Gravity	95
36. Mineral Crystallization Disposes Also of Gravity and Imposes Massive Copying	97
37. The Egg Contents Rotate and the Cells Move within the Embryo Independently of Gravity	99
38. Snails Have a Shell in the Form of a Spiral Which Is Either Left-Handed or Right-Handed — The Choice Is Determined by Genes Which Orient the Axis of Cell Division Independently of Gravity	101

39. It Comes as a Revelation that the Chromosome Does Not Need Strong Magnets and Extreme Low Temperatures to Evade Gravity	104
40. Goddesses Do Not Obey Earthly Laws	105
References	107
Sources of Illustrations	110
Part III Who Cares for Randomness	113
41. Randomness Was Originally Foreign to Science	115
42. Randomness Is an Economic Concept Introduced into 17th Century Science	117
43. Randomness Is Synonymous with Ignorance — “The Folly of Probability”	122
44. It Took the Last 20 Years to Demonstrate that What Were Considered Chromosome Accidents Were Ordered Events	124
45. The Transmission of Hereditary Traits — From Confusion to the Ability to Predict	125
46. Mutation Has Been the Main Example of a Random Event	127
47. How the Prevailing Fashion Led to Fashionable Results, or How Random Mutations Turned Out to be Non-Random	128
48. Rearrangements that Were Random Events Turned Out to be Directed by Mobile Elements	131
49. The Repeat Sequences of the Human Genome Are, Instead of Being “Junk,” a Treasure Trove of Information	133
50. Genes with Similar Functions Could Not be Located Nearby — Random Mutations and Rearrangements Would Disrupt Any Possible Order	134
51. The Gene Turns Out to Consist of a Highly Ordered Procession of DNA Stations Locked by Well Defined Starting and Finishing Sites	137
52. The Gene Is Never Alone	141

53. The Periodic Packaging of DNA Along Chromosomes Has Turned Out to be Predictable	142
54. In Cell Division the Proper Movement of Chromosomes Is Maintained by Correction of Improper Attachment to the Moving Apparatus	143
55. Cells Sense and Stop Uncontrolled Divisions Released by Cancer Stimuli. Moreover, RNAs Are Able to Silence Genes	145
56. Prevention of Failing of Chromosome Pairing and of Recombination	148
57. Brownian Motion — The Trap of the Physicist and Biologist	150
58. The Cell Was Seen as a Pea Soup, But Now Most of Its Molecules Are Known to Have an Address	152
59. “The Genetic Code Is Certainly Not Random”	155
60. Noise Is Disorder — Music Is Order and Unity	156
61. The Distinction between Genetic Noise and Genetic Music	157
62. “Errors” Are Not of All Possible Kinds	159
References	160
Sources of Illustrations	164
Part IV Who Cares for Selection	167
63. Selection Is a Political, Not a Scientific Concept	169
64. Three Myths in Science: Phlogiston in Chemistry, Ether in Physics and Selection in Biology	172
65. Definitions of Selection	175
66. Selection Is Not a Material Component that Can be Measured	177
67. The Distinction between Evolution and Darwinism	178
68. The Merits and Limitations of Darwinism	180
69. An Interpretation of Evolution Based on Physico-Chemical Processes	181
70. How the Chromosome Evades Selection	183

71. A Chaotic Chromosome Could Not Evade Selection But an Organized One Cannot Do Anything Else But Circumvent It	184
72. The Chromosome Does Not Need Selection to Conserve, Innovate and Explore	186
73. Repair Mechanisms Ensure the Maintenance of Order by Occurring at Different Molecular Levels — The Production of DNA, RNA and Protein Are Under Different Types of Control	187
74. Without DNA Repair No Human Would Exist	188
75. RNA Integrity Which is an Obligatory Condition for Normal Cell Function Is Maintained by Another Type of Repair	191
76. RNA Surveillance — An Additional Mechanism that Improves Safety by Creating Quality Control	193
77. “Molecular Chaperones” Are Proteins that Ensure that a Correct Molecular Assembly Will Predominate	197
78. How to Confuse Evolutionists — The Correction Can Function Backwards, Ancestral RNAs Can Restore the Original DNA Sequence	199
79. Innovation by Creation of New Gene Sequences	201
80. Exploration Is Achieved by Change of Genetic Pathways into New Functional Alleys	203
81. How Plasmids and Accessory Chromosomes Evade Selection	205
82. There Are Genes Which Are Able to “Cheat” Natural Selection	207
83. Sensing Mechanisms Are Used by the Chromosome to Adjust Gene Number and Switch on Genes That Improve Survival	208
84. The Multitude of Protective Mechanisms Devised by the Chromosome “Prohibit Natural Selection”	210
85. The Aggregation and Cell Adhesion of <i>Dictyostelium</i> Cells Follow the Same Chemical Solutions Employed by Embryos of Higher Organisms	212

86. The Egg Is a Storehouse of Information, Prepared by the Mother's Chromosomes — This Guarantees the Formation of an Identical Body Pattern	213
87. The Genetic Code Does Not Contain Direct Information to Produce a Coherent Organism — This Lies in the Hands of Other Molecular Processes that Charter Development by Building a Road Map	215
88. Minute Cell RNAs, that Previously were Despised, Turn Out to Coordinate Messenger RNAs	216
89. The Mechanisms Responsible for Coherence and Order Have Been Experimentally Demonstrated	218
90. The Drastic Reshapings that Occur in the Embryo Are Directed by Specific Proteins	220
91. Cells of One Group Change the Shape, Mitotic Rate and Pattern of Their Neighbors	225
92. The Chromosome Has Made Sure that the Organism Not Only Protects Itself from Inner Errors But Also from Outer Enemies	227
93. Cell Death Is as Programmed as Cell Life	229
94. Cells Can Commit Suicide but Amoebae Are Potentially Immortal	231
95. Both the Cell and the Chromosome Have an Unfailing Memory	232
96. When King Louis XV of France Was Going to be Married, the Princess in Question Could Give Birth to Rabbits	237
97. Why Should a Woman Not Produce a Mouse	239
References	242
Sources of Illustrations	249
Part V Who Cares for Magnetism	251
98. Magnetism and Electricity Are Two Manifestations of the Same Phenomenon	253
99. Bacteria, Bees, and Pigeons Orient According to the Magnetic Field	257

100.	Cells Generate Electricity and Magnetism	260
101.	When Magnets Are Divided into Minor Pieces, Each Separate Unit Continues to Behave as a Magnet, Acquiring New North and South Poles, But Small Magnets Can Also Rebuild Large Ones	262
102.	When Fertilized Eggs Are Divided into Separate Cells, Each Cell Acquires the Properties of the Initial Egg Giving Rise to Separate Embryos	264
103.	Separate Embryos Which Are Fused Result in a Single Normal Organism	267
104.	When Chromosomes Are Divided into Minor Pieces, Each Separate Unit Continues to Behave as an Independent Chromosome by Incorporating or Creating New Telomeres and Centromeres	270
105.	The Same Chromosomes May Disassemble and Reassemble Maintaining Their Genetic Properties — A Deer Species May be Formed with 35 or Only 3 Chromosomes	272
106.	Ants May be Produced Using a Single Chromosome But Also 94	277
107.	Plants of the Same Genus Have Been Formed with 4 or 36 Chromosomes	279
108.	A Protozoan Can be Produced with 2 Chromosomes But Also with 500	280
109.	In Birds and Plants a Series of Minute Chromosomes Are an Obligatory Component of Their Chromosome Set	281
110.	The Separation of Chromosomes into Minor Units, as well as Their Reunion, Follows Well-Defined Solutions	283
111.	The Properties Shared by Magnets and Chromosomes May Have Their Origin in the Polarization Already Present at the DNA Level	286
	References	289
	Sources of Illustrations	292

Part VI	Biological Order Is the Product of Self-Assembly and Self-Assembly Is the Product of Atomic Recognition	295
112.	How Clocks and Other Machines Differ from Cells	297
113.	Definition of Self-Assembly and Its Basic Properties	299
114.	The Mechanism Responsible for Self-Assembly Is Independent of External Information	302
115.	The Self-Assembly of an Enzyme Is So Rapid that It Takes Less Time than the Synthesis of Its Component Polypeptides	305
116.	No One Believed in the Self-Assembling Capacity of Viruses	306
117.	The Bacterial Virus <i>T4</i> Has a Programmed Pathway of Assembly that Has Been Described in the Utmost Detail	308
118.	The Self-Assembly of Ribosomes Has Been Obtained in the Test Tube	311
119.	Self-Assembly of the Chromosome Fiber and of Other Chromosome Structures Involved in Its Movement	313
120.	Single Sponge Cells Have the Information to Produce a Whole Organism	315
121.	A Hydra with Its Highly Complex Tissues can Self-Assemble from Dispersed Cells	316
122.	<i>Dictyostelium</i> Is an Impressive Example of the Cell's Organizing Capacity	318
123.	The Self-Assembly of Cells Leading to Tissue Formation Is Like the Precipitation of Crystals Out of a Solution	321
124.	The Unfailing Power and Accuracy Inherent to Self-Assembly — The Nuclear Envelope Has Reassembled with Precision during an Untold Number of Cell Divisions	323
	References	326
	Sources of Illustrations	330

Part VII	Where Did the Chromosome Come From and Where Is It Going	333
125.	“Where Do We Come From? What Are We? Where Are We Going?” Paintings Which Represent the Origin of Life and of the Chromosome	335
126.	The Origin of the Cell and of the Chromosome Are not Known	339
127.	The Origins of the Chromosome Can Be Traced Back to the Periodicity of the Chemical Elements	342
128.	Anomalies Exist at the Level of Chemical Periodicity, but the Alternatives Are Already Limited	346
129.	The Unique Position in the Periodic Table of the Atoms Used in the Construction of the Cell and the Chromosome — So Far There Is No Evidence that Matter Suddenly Changed Its Laws When the Chromosome Emerged	348
130.	Evolutionary Decisions Which Were Made Before DNA Arrived on the Scene	351
131.	The Role of DNA in Heredity Is Not as Powerful as We Tend to Believe	356
132.	The Whole Human Genome May Be Packed into a Single Chromosome	359
133.	Where Is the Chromosome Going?	360
134.	Physics Is Still an Underdeveloped Science, but It May Hold the Key to the Understanding of Chromosome Behavior	362
	References	367
	Sources of Illustrations	370
	Simplified Glossary	373
	Acknowledgements	378
	Name Index	379
	Subject Index	389