

Contents

Foreword	III
<hr/>	
CHAPTER 1	
Introduction	1
<hr/>	
CHAPTER 2	
The Formation of Terrestrial Planets	9
2.1 From Antiquity, the Myth of the Plurality of Worlds.....	9
2.2 The Primordial Nebula Model.....	11
2.3 The Formation of Stars and Discs.....	13
2.4 The Formation of Terrestrial and Giant Planets	16
2.5 The Migration of Planets	19
2.6 The Late Heavy Bombardment and Its Consequences	21
2.7 The Formation of Planets in Exoplanetary Systems.....	23
2.8 The Primary Atmospheres of the Terrestrial Planets	24
2.9 What Atmospheres for Rocky Exoplanets?	25
<hr/>	
CHAPTER 3	
The Exploration of Terrestrial Planets	27
3.1 The First Modern Observations	27
3.2 The Myth of the Martian Canals	29
3.3 The Physical Nature of Planets.....	30
3.4 The Beginning of the Space Era	30
3.5 The Viking Mission: Hopes and Disillusions	32
3.6 From Mars to Venus.....	33
3.7 The Renewal of Martian Exploration	35
3.8 Return to Venus	39
3.9 Mars and Venus Today	41
3.10 Between Venus and Mars, the Earth	42
3.11 Towards a Comparative Study of the Terrestrial Planets	46

CHAPTER 4

Venus, Earth and Mars: A Diverging Evolution	47
4.1 The Astonishing Variety of Terrestrial Planets	49
4.2 And Yet... Common Characteristics	52
4.2.1 The Thermal Structure of the Terrestrial Planets	53
4.2.2 Atmospheric Circulation	54
4.2.3 Internal Structure and Volcanism	55
4.3 Terrestrial Planets at the Origin	56
4.3.1 Secondary Atmospheres	56
4.3.2 Primitive Atmospheres Rich in Water	57
4.3.3 The Paradox of the “Young Sun”	59
4.4 History of the Terrestrial Planets: A Divergent Evolution	61
4.4.1 Venus: The Ravages of a Runaway Greenhouse Effect	61
4.4.2 Mars: A Planet on the Verge of Geological Extinction	62
4.4.3 The Earth, Ideally Located in Relation to the Sun	63

CHAPTER 5

The Appearance of Life	65
5.1 What is Life?	65
5.2 From Spontaneous Generation to Primordial Soup	66
5.3 The First Experiments in Prebiotic Chemistry	68
5.4 The Building Blocks of Terrestrial Life	70
5.5 The Origin of Prebiotic Molecules	73
5.6 The Rise of Complexity from Prebiotic Molecules	75
5.7 The Formation of Cells	76
5.8 Metabolism and the Question of Energy	78
5.9 The Genetic Code	79
5.10 The Ancestor of All Living Beings?	79
5.11 Life on Earth as a Model for Life on Other Planets?	81
5.12 The Beginnings of Life on Earth	82
5.13 Life on Exoplanets	83

CHAPTER 6

The Development of Life on Earth	85
6.1 The Paradox of the “Young Sun”	85
6.2 The Major Stages in the Evolution of the Earth’s Climate	87
6.2.1 From Hadean to Archean	87
6.2.2 From Archean to Proterozoic: The Great Oxidation Event	89
6.2.3 The Phanerozoic: Life on the Continents	91
6.3 What Future for the Earth’s Atmosphere?	94
6.4 What Lessons for Exobiology?	96

CHAPTER 7

Life in the Solar System?	99
7.1 The Habitability Zone in the Solar System	99
7.2 A Past Ocean on Venus?	102
7.3 Searching for Traces of Life on Mars	104
7.4 Other Niches in the Solar System	106

CHAPTER 8

How to Search for Life on Rocky Exoplanets?	113
8.1 The Discovery of Exoplanets: Where Do We Stand?	113
8.2 The Exoplanet Concept: An Old Idea	117
8.3 Early Discoveries	118
8.4 The Successes of Velocimetry	119
8.5 A New Step: The Transit Method	120
8.6 How to Search for Life on an Exoplanet?	124
8.7 Satellites Around Giant Exoplanets?	126
8.8 How to Determine the Atmospheric Composition of an Exoplanet?	127
8.9 How to Search for Life from the Spectrum of an Exoplanet?	129

CHAPTER 9

Conclusions: Some Future Directions in Exobiology	135
9.1 The Future of Mars Exploration	135
9.2 How to Detect Traces of Life <i>In Situ</i> ?	139
9.3 Towards an Inhabited Exploration of Mars?	139
9.4 Towards External Satellites, Other Possible Niches for Life	141
9.5 Exploring Exoplanets: The Prospects	142
9.6 What If We Were Not Alone?	146
Glossary	149
Bibliography	155