

CONTENTS

INTRODUCTION	1
CHAPTER 1. THE OVERVIEW EFFECT	11
A Pale Blue Dot	12
Are We Alone in the Universe?	14
Coevolution: A Key Principle	17
Natural Cycles and Cosmic Threats	20
CHAPTER 2. SPARKS OF LIFE	27
The Origin(s) of Life on Earth	27
What Role for the Moon?	30
Life from Space?	33
Biogeochemical Theories of the Origin of Life	35
Conditions for Life's Inception	38
New Concepts	42
Changing Paradigm	44
CHAPTER 3. VENUS AND ITS VEIL OF SECRECY	47
The Phosphine Mystery	48
An Active Volcanism on Venus?	53
A Very Strange Planet	55
Different Scenarios for Habitability on Venus	57
A Supercritical Fluid	59
Promising Missions	60

CONTENTS

CHAPTER 4. BLUE SUNSETS	63
Mars: A Myth Always Renewed	64
Did Viking Find Life on Mars?	66
Mars, Always in Sight	70
A Habitable Planet Early in Its History	74
Revelations in a Meteorite	76
Dry and Cold, but Certainly Not Dead	79
The Carbon Trail	82
Deep into the Martian Crust	86
Did Life on Earth Come from Mars?	88
 CHAPTER 5. PLANETARY SHORES	 91
Ocean Worlds	91
Frozen Kingdoms	93
Many Candidates	96
Mysterious Enceladus	100
Exploring Ocean Worlds	104
Fascinating Europa	106
 CHAPTER 6. TITAN: A WORLD OF UNKNOWNNS	 111
First Images of Titan	112
A Peculiar Atmosphere	114
Raining Methane	116
Life in a Frozen Soup?	121
Scenarios for Life in a Subsurface Ocean	123
Dragonfly	126
 CHAPTER 7. NEW HORIZONS	 130
Sizable Surprises	130
Pluto's Extraordinary World	135

CONTENTS

Unexpected Activity	138
Relics from an Ancient Ocean?	142
New Candidates	145
Pushing Back the Limits of Habitability	147
A Brand-New Deal	150
 CHAPTER 8. REVOLUTIONS IN THE NIGHT SKY	 153
Toward a Cosmic Pluralism	153
Dots in the Night, or How to Detect Exoplanets	156
First Detections	160
Observatories in the Sky	162
A Revolution Named Kepler	164
Exhilarating New Missions	166
 CHAPTER 9. VISIONS OF TATOOINE AND MORDOR	 170
An Increasingly Large Gallery of New Worlds	170
Rogue Planets	174
When Reality Meets Fiction	178
Seeking Earth 2.0	181
TRAPPIST-1	184
The Role of Artificial Intelligence in Exoplanet Detection	186
 CHAPTER 10. ECHOES OF COSMIC WAVES	 189
In Search of Complex Life: The Drake Equation	190
Potential Candidates for Technologically Advanced Civilizations	197
The Fermi Paradox	202
The Rare Earth Hypothesis	203
Radical Hypotheses	208

CONTENTS

CHAPTER 11. CONNECTING BLUE DOTS	211
Scenarios for Advanced Extraterrestrial Civilizations	211
The SETI Projects	215
Probing the Cosmic Ocean for Signals	221
UAPs	225
CHAPTER 12. PARADOXES, PARADIGMS, AND THE GRAMMAR OF LIFE	231
Sandwich in Hand	232
The Plumbing of Life	234
Looking for Definitions	239
Artificial <i>and</i> Alive?	243
Artificial Intelligence, Transhumanism, and Ethical Dilemmas	245
It Is Not by Chance	248
EPILOGUE. TIME AS A COSMIC MIRROR	251
Pathways and Destinies	252
Course Correction	255
Interstellar	259
ACKNOWLEDGMENTS	265
IMAGE CREDITS	269
NOTES	275
INDEX	283