

Contents

- 1 Introduction 1**
 - References 4

- 2 Space and Ground-Based Infrastructures 7**
 - 2.1 Characteristics of the Space Environment 7
 - 2.1.1 External Environmental Conditions 8
 - 2.1.2 Internal Spacecraft Environmental Conditions 8
 - 2.2 Space Infrastructure 9
 - 2.2.1 The International Space Station 9
 - 2.2.2 Foton/Bion Recoverable Capsules 30
 - 2.3 Non-orbital Weightless Research Platforms 31
 - 2.3.1 Sounding Rockets 32
 - 2.3.2 Parabolic Flight Airplanes 33
 - 2.3.3 Drop Towers 35
 - 2.3.4 High-Altitude Balloons 36
 - 2.4 Ground-Based Facilities and Space Simulators 37
 - 2.4.1 Bed Rest, Hypokinesia and Metabolic Balance Facilities 37
 - 2.4.2 Isolation and Confinement, Pressure Chambers
and Climate Chambers 38
 - 2.4.3 Centrifuges 39
 - 2.4.4 Human-Rated Linear and Angular Accelerators 41
 - 2.4.5 Clinostats, Free Fall Machines, and Random
Positioning Devices 42
 - 2.4.6 Telemedicine, Behaviour and Metrics 43
 - 2.4.7 Integrated Bio-Processing, Tissue Engineering 44
 - 2.4.8 Magnetic Resonance Facilities 45
 - 2.4.9 Movement Analysis, Physical and Skills Training 45
 - 2.4.10 Additional Animal Physiology Facilities 45
 - 2.4.11 Additional Plant Physiology Facilities 46
 - 2.4.12 Magnetic Levitation 46

2.4.13	Biotechnology and Life Support Systems	47
2.4.14	Extreme Environments	47
2.4.15	Radiation Testing	48
2.4.16	Fluid Science Facilities: Surface Tension	49
2.4.17	Materials Science Facilities: Crystallisation	49
2.4.18	Materials Science Facilities: Solar Power	49
2.4.19	Materials Science Facilities: Wind Tunnels	50
	References	50
3	Areas of Research	55
3.1	Physical Sciences	56
3.1.1	Fundamental Physics	56
3.1.2	Fluid Physics by Daniel Beysens	64
3.1.3	Combustion by Christian Chauveau	75
3.1.4	Materials Science	81
3.1.5	Space Weather by Hanna Rothkaehl	97
3.2	Life Sciences	103
3.2.1	Astrobiology	103
3.2.2	Gravitational Cell Biology	107
3.2.3	Radiation Biology	113
3.2.4	Plant Sciences	117
3.2.5	Animal Physiology	123
3.2.6	Human Physiology	129
3.2.7	Psychology	141
3.2.8	Research for Operational Space Medicine	145
3.2.9	Research on Life Support Systems	153
	References	157
4	ULISSE Access to Data	171
4.1	Data Description	171
4.1.1	Preservation of Space Data	171
4.1.2	Main Space Databases	172
4.1.3	Preservation and Valorisation Approach	173
4.1.4	Initial Production of Data	174
4.1.5	Data Support and Storage	177
4.1.6	Data Resulting from the Experiments and Processing Levels	178
4.1.7	Data Formats	181
4.1.8	Samples	182
4.1.9	Legal Aspects and Ethical Issues	183
4.2	Identification of Information: The ULISSE Knowledge Base	185
4.2.1	Purpose and Role of Semantic Technologies	185
4.2.2	Topic Maps as a Semantic Data Model	186
4.2.3	The ULISSE Knowledge Base	192

Contents	xi
4.3 ULISSE: Data Access Services	196
4.3.1 Services for Obtaining Data	196
4.3.2 ULISSE Services	199
4.3.3 Example of a Searching and Browsing Session	202
References	205
Index	207