

# Contents

<b>1</b>	<b>General Introduction . . . . .</b>	<b>1</b>
1.1	Human Motions and Performance on Earth . . . . .	1
1.2	Human Motions and Performance in Space . . . . .	4
	References . . . . .	6
<b>2</b>	<b>Skeletal Muscle . . . . .</b>	<b>9</b>
2.1	Skeletal Muscle Structure and Function . . . . .	10
2.1.1	Functional Anatomy of Normal Human Skeletal Muscle . . . . .	10
2.1.2	The Reinforcement Structures: Human Resting Myofascial Tension (HRMT) System and Enthesis Organs (Including Tendons) . . . . .	12
2.1.3	The Little Power Chambers Inside: Sarcomere, Sarcoplasmic Reticulum (SR), and More . . . . .	13
2.1.4	Muscle Works Against Gravitational Forces on Earth . . . . .	15
2.1.5	Current Definitions of Human Skeletal Muscle Contraction Types Under Normal Gravity Conditions on Earth (1G) . . . . .	15
2.1.6	Histologic and Molecular Adaptation in Normal, Atrophic, and Gravitational Unloaded Skeletal Muscle . . . . .	17
2.1.7	NO Signals in Muscle: Nitric Oxide (NO) Produced by NO-Synthase (NOS) as Multifunctional Signals in Normal Muscle Physiology . . . . .	20
2.2	Lessons Learned from Ground-Based and Spaceflight Experiments . . . . .	23
2.2.1	Animal Studies on Earth . . . . .	23
2.2.2	Animal Studies in Spaceflight . . . . .	26
2.2.3	Human Studies (Bed Rest) . . . . .	31
	References . . . . .	51

<b>3 Neuromuscular System</b>	63
3.1 Introduction	63
3.2 Where the Nerve Meets the Muscle: Neuromuscular Synapse	64
3.2.1 Presynaptic Structure and Function	65
3.2.2 Synaptic Cleft Structure and Function	66
3.2.3 Postsynaptic Membrane Structure and Function	67
3.3 Molecular Mechanism of NMJ Adaptation to Disuse and Exercise	67
3.4 Neuromuscular System Adaptation to Spaceflight	69
3.5 Role of Scaffold Adaptor Homer Proteins in Skeletal Muscle	70
3.5.1 Mice with a Specific Deletion of Homer1 Develop Skeletal Muscle Myopathy	71
3.5.2 Skeletal Muscle Regeneration Characterized by Transition of Homer-specific Isoforms	72
3.5.3 Regulation of Homer Expression in Denervated Myofibers	72
3.5.4 Hind-Limb Unloading (HU) Decrease Homer Expression	72
3.5.5 Regulation of Myogenic Differentiation Program by Homer	73
3.5.6 Homer Localize in Skeletal Muscle-Specific Subcellular Compartments	73
3.5.7 Role of Homers in Skeletal Muscle Atrophy	73
3.6 Homer Proteins in Bed Rest: Elucidating Signaling Pathways	75
3.6.1 Resistive Vibration Exercise Increased NFATc1 Proteins at the NMJ Which Fully Correlates with Homer2 Changes	76
3.6.2 Homer Scaffold Might Be Required for NFATc1 Recruitment at the Skeletal Muscle NMJ	76
3.6.3 Resistive Vibration Exercise Significantly Increased NFATc1 Positive Myonuclei	77
3.7 Vibration Exercise as a Reliable Tool to Stimulate the Myogenic Differentiation Program in C2C12 In Vitro Cell Model	79
3.8 The NMJ in Spaceflight (Bion-M1 Mission)	81
3.9 Risk Factors and Possible Constraints Using Whole Body Vibration Stimulation	83
Conclusion and Perspectives	83
References	84
<b>4 Physical Countermeasure in Space: Efforts in Vain?</b>	89
4.1 Current Inflight Countermeasures and Perspectives	89
References	91

The NeuroMuscular System: From Earth to Space Life  
Science

Neuromuscular Cell Signalling in Disuse and Exercise

Blottner, D.; Salanova, M.

2015, XIV, 92 p. 34 illus., 30 illus. in color., Softcover

ISBN: 978-3-319-12297-7