

State of the Art and Future Challenges in Neural Engineering: Strategies for Nervous System Repair Foreword / Editors' Commentary (Volume 2)

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This issue of *Critical Reviews in Biomedical Engineering* is volume two of a three volume series focused on neural engineering. The theme of this volume is “Strategies for Nervous System Repair.” These articles present a range of biomedical engineering strategies to improve outcomes with specific focus given to neural tissue engineering and biomaterial strategies for the repair of spinal cord and peripheral nerve injury. These articles emanate from a unique workshop presented at the 2009 Biomedical Engineering Society Annual Meeting in Pittsburgh, PA, titled “Tissue Engineering of the Nervous System: Approaches and Strategies for the Repair of Peripheral and Spinal Cord Injuries.” At times, neurobiologists can be wary of tissue engineering due to a misunderstanding of an engineering approach, or due to an engineer’s design that disregards aspects of the surrounding biology, neuroanatomy, or the goals of the surgeon. For instance, *novel* biomaterial scaffolds are frequently proposed; however, the biology beyond the material is not often considered. In other cases, the efficacy of a new tissue-engineering approach is not evaluated against the gold standard clinical treatment or in the best injury model. This workshop brought leading neurobiologists, clinicians, and engineers together to redefine and revitalize the tissue engineering approach to nervous system repair. Presentations from leading experts addressed the state of the art, identified key challenges, and discussed the most promising opportunities for progress. The articles in this volume were formulated from the resulting discussions.

In the first article “Biomedical Engineering Strategies for Peripheral Nerve Repair: Surgical

Applications, State of the Art, and Future Challenges,” key clinical and neurobiological perspectives were provided by Dr. Susan Mackinnon, Washington University, Division of Plastic and Reconstructive Surgery, and Dr. Tessa Gordon, Division of Neurosciences, University of Alberta. Dr. Mackinnon specializes in nerve transplantation, peripheral nerve surgery, and plastic and reconstructive surgery. Her numerous contributions have advanced our understanding of nerve regeneration, developed and validated clinically applied nerve guidance channels, and pioneered cutting-edge surgical techniques for extensive or complex nerve injuries. Dr. Gordon is a leading expert on neuromuscular plasticity after nerve injury and disease. Her research explores the basis for poor functional recovery and the loss of functional motor units following a peripheral nerve injury. Her work has uncovered key neurobiological changes that underlie axon regeneration and motor unit survival.

The second article, “Biomaterial Design Considerations for Repairing the Injured Spinal Cord,” was a collaborative effort between lead authors Dr. Ryan J. Gilbert and Dr. Philip Popovich. Dr. Gilbert is an Assistant Professor in Biomedical Engineering at Rensselaer Polytechnic Institute. His lab focuses on the development of novel biomaterial scaffolds for the treatment of spinal cord injury (SCI) to reduce secondary injury and promote axonal regeneration. Dr. Popovich is a Professor of Neuroscience at Ohio State University. He is a leading expert in neurotrauma and tissue repair, in particular regarding acute and chronic neuro-inflammatory responses driving secondary sequelae following brain and spinal

cord injury. His interdisciplinary research group is exploring the consequences of resident and recruited inflammatory cell activation on axonal injury, demyelination, and neurological function in animal models of SCI.

The authors in this volume summarize the experience and knowledge of leading scientists and clinicians in the field of nervous system injury and repair. Importantly, the wisdom and insight of the

faculty that presented at the workshop provided valuable perspective regarding current approaches and limitations, defining what is needed to improve outcome, and promoting interdisciplinary research by highlighting emerging tissue engineering strategies. Overall, these articles highlight several ways biomedical engineers can contribute to improving strategies and/or creating new approaches to nervous system repair.