Preface

Psychoneuroimmunology (PNI) has developed rapidly in the last four decades. As a multidisciplinary area, PNI may provide a scientific basis for mind–body relationships toward the development of personalized and systems medicine. Although it is still an emerging field, it already has profound influences across all of the biomedical community. The biopsychosocial model is becoming the central theme for understanding health and diseases. Such understanding would contribute to more accurate diagnosis and better therapeutics in personalized medicine.

This book has several features that readers may find helpful to their work. First of all, it focuses on translational medicine by applying PNI approaches in clinical practice. One of the major challenges in current bioscience is the translation of basic scientific discoveries into better clinical outcomes. This book is written in response to this challenge by highlighting the clinical implications of PNI.

We hope that these approaches may help trigger some breakthroughs and advancement toward the realization of personalized and mind–body medicine, which is also the second feature of the book. That is, many of the methods and protocols described in the book are geared toward the development of integrative and individualized therapeutics in multiple dimensions from drugs to behaviors.

The third feature is that this book provides both practical methods and comprehensive resources that can be used for solving complicated problems of complex systems. A wide range of theoretical and experimental approaches are introduced with problem-solving objectives, from laboratory tests to computational analysis.

The fourth feature is that this book integrates the advancement of science with innovative technologies. While the first part of the book describes basic concepts and important topics in PNI, the second and third parts illustrate how the concepts and technologies can be applied for disease understanding and improving clinical interventions.

Part I of the book introduces basic and novel concepts in PNI, especially the relationship between stress and immunity, one of the most important topics in PNI. In this part, the association between stress and immunity is discussed in details from different aspects and various levels, including how immune cells respond to stress, the roles of neuroendocrine receptors, as well as the influences of job stress and life experiences. Some mechanisms of potential interventions are also described, such as the effects of physical activity.

This part explains how PNI may provide the scientific basis for the practice of mind–body medicine as well as personalized and systems medicine (see Chap. 1). Some relevant topics and concepts are discussed, such as biopsychosocial models, translational medicine, and systems biology. The close relationships among stress, depression, and inflammation are explored, as well as the clinical implications in diseases including obesity, cardiovascular disease, diabetes, arthritis, skin diseases, infectious diseases, and sleep disorders. Integrative interventions in multiple dimensions for modulating stress responses and promoting healthier behaviors are also proposed, such as drug therapies, diets, nutritional supplements, meditation, and other behavioral and mind–body strategies.

Evidences have shown that life experience has fundamental biological relevance with impacts on all adaptive systems such as the endocrine, immune, and nerve systems, with profound meanings on health and diseases (see Chap. 2). Even though experience is often ignored in the research of PNI, it deserves more attention for understanding the dynamic interplay between mind, body, behavior, and environment. Such exploration may allow meaningful and relevant interpretation and predictions in PNI.

Specifically, meta-analyses of the association between psychosocial job stress and immune parameters in blood, saliva, and urine have found that stresses such as high job demands, low job control, and economic recession are related to disrupted immune responses (see Chap. 3). At the molecular and cellular levels, studies of the neuroendocrine receptor activity by immune cells and neuroimmune responses may provide insights into the pathophysiological mechanisms of health and disease (see Chap. 4).

Integrative and multidimensional interventions have been found helpful for relieving stress and relevant diseases. For example, regular exercise may be associated with stress reduction and better mood (see Chap. 5). Epidemiological evidences have shown the relationships between physical activity and mental health. The inflammatory response has been considered a central mechanism underlying such correlations.

Part II of this book focuses on the clinical implications of these concepts and methods in the translation of PNI into the understanding of various disease states and development of personalized therapeutics. Because biomarkers play critical roles in the practice of personalized medicine, translational implications of potential biomarkers in various disorders are discussed in details in this part.

Among the potential PNI biomarkers, inflammatory markers deserve special attention as they play a pivotal role linking various health conditions and disorders including depression, obesity, cancer, cardiovascular diseases, Alzheimer's disease, and HIV (see Chap. 6). Applications of systems biology approaches would enable the insights into the correlations among various systems for the identification of the basic elements of the psychophysiological framework. The understanding of the cytokine networks, immune–brain–behavior interactions, and systemic pathways among different disorders may contribute to the transition from the disease-centered medicine to patient-centered medicine.

Specifically, cytokines are the central players in the neuroinflammatory cascades related to the neurodegenerative process in Parkinson's disease (PD) and other neurological disorders (see Chap. 7). With great promise as serological biomarkers in PD, cytokines have potential applications in diagnosis, prognosis, drug discovery, and analysis of treatment responses. On the basis of cytokine panel profiles, subclassification or risk stratification in PD can be defined, which is meaningful for the development of personalized interventions. The major cytokine multiplex assay platforms can be useful tools for biomarker discovery in PD and its cognitive comorbidities (see Chap. 7). In another example, complex disorders like Gulf War illness (GWI) can be distinguishable by measuring the co-expression of multiple markers, such as using a three-way multivariate projection model with 12 markers of endocrine and immune functions (see Chap. 8).

Depressed heart failure (HF) patients often have worse clinical outcomes than the nondepressed counterparts. PNI principals can be applied to elucidate the mechanisms such as cytokine activation connecting the comorbid disorders (see Chap. 9). In cancers, recent studies have found that the prognosis not only depends on the biological features of tumors, but also on the immune status of cancer patients that is under a psychoneuroendocrine

control. The therapeutic approach based on PNI for the treatment of cancer should try to reestablish the neuroimmune conditions (see Chap. 10).

In addition, the impact of immune activation on the central nervous system (CNS) is especially important for aged individuals. Effective treatments must reduce inflammatory activity and preserving microglia's neuroprotective function at the same time. Discovering factors of neuroinflammation may contribute to potential preventative therapies for maintaining normal microglia activity in the aged brain (see Chap. 11).

Furthermore, immune functions have been associated with autism spectrum disorders (ASD), e.g., some genes related to immune regulation are changed in ASD. Many systemic and cellular immune abnormalities have been found in individuals with ASD and their families, such as changes in cytokine and chemokine production with increasing impairment in behaviors. Understanding of the interactions between the nervous and immune system during early neurodevelopment may have important therapeutic implications (see Chap. 12).

Part III of this book introduces various cutting-edge technologies models for PNI studies, from experimental approaches to data analysis and decision support. These technologies include the utilizations of mouse models, the chromium release whole blood assay, imaging techniques, vaccine models, as well as translational bioinformatics.

Specifically, mouse models have extensive applications in PNI studies. Immunobehavioral phenotyping is a first-line approach for exploring the neuroimmune system and its reactions. Behavioral tests are frequently used to examine neuroimmune activation in mice (see Chap. 13). The murine MRL model with high validity in revealing principal pathogenic circuits has been considered indispensable in understanding the brain-immune links (see Chap. 14). In addition, mouse models have been useful for examining the effects of the complex biology of cytokines such as IL-2 on multiple systems. Models such as congenic IL-2 knockout mice can be applied to investigate neuroimmunological processes in neurological diseases such as Alzheimer's disease and schizophrenia, as well as autoimmune diseases such as multiple sclerosis (see Chap. 15).

Natural killer (NK) cells are sensitive barometers of the effects of stressors on the immune system. A chromium (51Cr) release whole blood bioassay can be used to measure the target cell killing capacity of NK cells (see Chap. 16). Positron emission tomography (PET) imaging is a tool for measuring brain metabolism and target molecules. By detecting brain variables, PET imaging can be combined with other experimental and clinical model systems for PNI research (see Chap. 17).

In addition, vaccination models are very useful for the examination of the effects of psychosocial factors on immunity (see Chap. 18). Such protocols can help elucidate the association between stress and the vaccination response. These models can be applied for promoting vaccine responses in at risk populations by assisting decisions on the choice of vaccination, timing of assessments, and the available outcome measures (see Chap. 19).

Furthermore, translational bioinformatics provides a powerful method to bridge the gaps between various knowledge domains in PNI and systems biology (see Chap. 20). Translational bioinformatics methods at various systems levels are introduced. These methods can facilitate pattern recognition and expedite the discovery of systemic biomarkers for clinical trials and outcome assessments. Methods and applications of data integration, data mining, and decision support in PNI are also discussed.

By covering topics from fundamental concepts to advanced technologies, this book can be used by biomedical students and professionals at all levels who are interested in integrative

studies in psychology, psychiatry, neuroscience, immunology, PNI, molecular biology, genetics, bioinformatics, bioengineering, biochemistry, physiology, pathology, microbiology, pharmacology, toxicology, systems biology, drug discovery, and clinical medicine. Written by leading experts in the field, this book intends to provide a practical, state-of-the-art, and holistic view for the translation of PNI into better preventive and personalized medical practice.

I would like to thank all of the authors for sharing their profound thoughts and experiences, and for making valuable contributions to this exciting new field. I also thank the series editor, Dr. John Walker, for his help with the editing.

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http://www.springer.com/978-1-62703-070-0

Psychoneuroimmunology
Methods and Protocols
Yan, Q. (Ed.)
2012, XII, 405 p., Hardcover
ISBN: 978-1-62703-070-0
A product of Humana Press