Preface

The use of animal models has become increasingly important for biomedical research over the past decade, enabling a better understanding of pathogenic pathways involved in a variety of human disorders. Within the realm of neurobehavioral research, animal models have played a crucial role in the development of new insights and theories of brain pathogenesis. Animal models such as mice, hamsters, and rabbits have been utilized in a multitude of neurobehavioral studies, yielding experimental data that have lead researchers to a better comprehension of neurobiology. As scientific research progresses, investigators are attempting to identify more novel animal models to utilize in new avenues of neurobehavioral research.

Zebrafish (*Danio rerio*) have become increasingly popular in biomedical research. Research conducted on these aquatic vertebrates has generated considerable discoveries not only in the areas of genetics and embryology but also in fields such as cardiology, endocrinology, and neuroscience. Zebrafish are promising animal models because of their high genetic homology with humans and quantifiable behavioral and neuropathological phenotypes analogous to humans.

The use of zebrafish to investigate the pathological mechanisms underlying neuropsychiatric disorders and behavior quantification is explored in depth in this book. The opening **Chapter** 1 is a comprehensive review of zebrafish behavior, ecology, taxonomy, reproduction, and genetics. This chapter emphasizes the need for continued experimentation in cognition, behavior, and field-based studies, resulting in a more thorough understanding of the zebrafish model.

Critical to survival in a natural habitat and strongly influencing their behavior, the olfactory system in zebrafish is explored in **Chapter** 2. Zebrafish possess three distinct types of olfactory sensory neurons, which integrate with other areas of the brain to induce various physiological and behavioral effects in response to odors. Olfaction allows zebrafish to detect nearby food, predators, and mates, in addition to conveying information relating to spawning sites, reproduction, dangerous environments, and the distinction between self and kin. Advanced knowledge of the neurological basis of olfaction is key to a better understanding of zebrafish wild type and anxiety-related behavior.

Chapter 3 focuses on the emergence of zebrafish as an effective model to study stress and anxiety. This chapter presents a concise introduction to anxiety-induced endocrine and behavioral responses in zebrafish. Since zebrafish possess all the classical vertebrate transmitters, and their neuroendocrine system yields robust cortisol responses to stress, zebrafish models enable greater insight into neural mechanisms associated with anxiety-related disorders. Furthermore, this chapter illustrates the importance of behavioral assays, genetic manipulation, pharmacological treatment, and video tracking for analysis of the phenomena involved in anxiety-related phenotypes.

While zebrafish demonstrate promising potential in the field of anxiety and stress-related research, they have also emerged as valuable models in other areas of neurobehavioral research. **Chapter** 4 describes how the effects of nicotine on processes such as learning, memory, and stress are similar to those exhibited by humans and rodents. The authors' analysis suggests that zebrafish may present significant translational capabilities in research as a model for the behavioral effects of nicotine.

Based on the establishment of zebrafish as a suitable model for behavioral research, **Chapter** 5 details the process for quantitative trait loci (QTL) mapping and how it attempts to discover the specific causative genes responsible for variations in complex behavioral traits in zebrafish. Because of the strides taken recently in the study of zebrafish behavior, QTL mapping would not only lead to a greater understanding of zebrafish activity, but also strengthen its application as a genetic model.

Chapter 6 explores the effects of alcohol on several strains of zebrafish. Like anxiety, alcoholism is a serious brain disease for which the pathogenic mechanisms are not well understood. Alcohol abuse in the world is on the rise, making a genetic model for the development of alcoholism vital. Using a noninvasive evaluation technique, the acute and chronic effects of ethanol on zebrafish were observed, clarifying the genetic factors involved in alcoholism.

Along the same line, the authors of **Chapter** 7 explore the use of zebrafish as a model of drug dependence and relapse behaviors in humans. These robust reactions to nicotine and alcohol not only reinforce the use of zebrafish as a behavioral model of addiction but also strengthen the notion that zebrafish may be utilized to discover various genetic factors underlying drug dependence, withdrawal, and relapse.

As previously mentioned, many neuroscientists seek to gain a more concrete understanding of the pathogenic mechanisms that induce neurobiological disorders and behavior. However, in some cases, an error in the mechanism of the neural circuitry is not the only contributing cause of behaviors or diseases that are expressed. **Chapter** 8 examines the impact of neurotoxic chemicals on the nervous system and their potential to increase susceptibility to neurodegenerative disorders. In this chapter, the authors utilize the high sensitivity of zebrafish to environmental changes to investigate the correlation between the influence of environmental neurotoxins and neurodegenerative disorders. This research analyzes alterations in the biogenic amine system following exposure to pesticides, as well as the detrimental effect of neurotoxins on the nervous system.

Other experiments that examine the neural effects of environmental factors are explored in **Chapter** 9. This chapter analyzes predator-avoidance behavior exhibited by zebrafish, which is induced by external environmental factors such as alarm pheromone. The predator-avoidance behavior displayed by zebrafish is based upon learned recognition of external environmental cues. Exploration into the process of learned recognition in zebrafish will enable researchers to gain a more tangible understanding of the mechanisms that underlie cognitive processes of learning and memory.

In **Chapter** 10, the authors discuss avoidance behavior in zebrafish. Similar to the learned recognition phenomenon, inhibitory avoidance paradigms provide insight into the learning and memory capabilities of zebrafish. While the behavioral phenotypes of small teleost fish have frequently been considered to be dominated by reflex and instinct, recent studies have suggested a more complex phenotype influencing emotional, social, and reproductive behavior. The authors employ new experimental models with zebrafish, and area to investigate learning and memory, and area of research that will contribute to a more comprehensive understanding of the zebrafish brain and behavior.

Further exploring the zebrafish neurocognitive domain, **Chapter** 11 reviews previous studies on the spatial cognitive abilities of zebrafish. Mounting evidence, summarized in this chapter, demonstrates the capability of zebrafish to learn from visual cues that identify potential risk or reward. The application of these tests may serve as an insightful resource by which the spatial cognition of zebrafish can be illuminated.

Finally, **Chapter** 12 describes common larval zebrafish behaviors. While the behavioral phenotypes of adult zebrafish are important to study in detail, the functionality of zebrafish larvae must be equally well understood in relation to its anatomical size and development. This chapter explores the scope of larval behavior, from movement to stimuli response to more complex behaviors such as swim bladder inflation, sleep, and social behavior. While a general repertoire may be established, specific behavioral tendencies are influenced by environmental factors such as temperature or nearby predators. Future experimentation is necessary to correlate the synergistic aspects of behavior and neurobiological development in zebrafish larvae.

Overall, this book emphasizes the growing importance of zebrafish in neurobehavioral research. As a promising alternative to mammalian animal models, zebrafish yield robust physiological responses analogous to humans but do not possess the complex behavioral phenotypes exhibited by many other animal models. This book portrays an extensive, thorough perspective on the emergence of zebrafish as a robust animal model in neuroscience research. The contributors to this book are leading international scholars whose work spearheads innovative research projects in laboratories around the world. The themes discussed within this book, ranging from stress-related behaviors to learning and memory phenotypes, encompass a wide spectrum of the utility of zebrafish within neurobiological disciplines. This theoretical book, as vol. 52 of the Humana Press Neuromethods series, complements another book ("Zebrafish Neurobehavioral Protocols", vol. 51) of this series, which focuses on practical laboratory applications of these concepts. Together, these two volumes will serve as a useful source for scientists new to the field, as well as established researchers seeking valuable insight into the growing utility of zebrafish in behavioral neuroscience.

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