Elucidating the Role of RNA-Binding Proteins in the Alternative Splicing of Pre-mRNA: A Case Study on Neuronal Development

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Abstract. RNA-binding proteins (RBPs) play critical roles in the regulation of alternative splicing (AS) of pre-mRNA, a fundamental process influencing gene expression and protein diversity. This study investigates the specific contributions of RBPs to AS during neuronal development using advanced molecular techniques, including RNA sequencing and RBP immunoprecipitation. Our results demonstrate that specific RBPs not only modulate splicing patterns but also impact neuronal differentiation and function. Furthermore, we identify key regulatory networks that involve RBPs and their interaction with splicing factors. Our findings provide insights into the molecular mechanisms governing neuronal development, with implications for understanding neurodevelopmental disorders. This research underscores the importance of RBPs in gene regulation and opens avenues for future investigations into therapeutic strategies targeting AS.

Keywords: RNA-binding proteins, alternative splicing, neuronal development, molecular techniques, gene regulation, neurodevelopmental disorders, pre-mRNA, splicing machinery, regulatory networks

Introduction

The regulation of gene expression is a complex and vital process that underpins all cellular functions. A significant aspect of this regulation is alternative splicing (AS), a mechanism

by which a single pre-mRNA transcript can give rise to multiple protein isoforms. This process is particularly crucial in the nervous system, where it contributes to the diversity of protein functions necessary for neuronal development and functioning. Recent studies have highlighted the pivotal role of RNA-binding proteins (RBPs) in orchestrating AS events, thereby influencing the splicing landscape of pre-mRNA. In the context of neuronal development, where precise temporal and spatial expression of proteins is essential, understanding the interplay between RBPs and splicing mechanisms is increasingly relevant. Neurodevelopmental disorders, which can arise from aberrant splicing events, further emphasize the need to elucidate these regulatory pathways. Despite significant advancements in our understanding of splicing regulation, the specific contributions of various RBPs during neuronal development remain to be fully understood. This paper aims to address this gap by providing a focused case study on the role of RBPs in AS during neuronal differentiation. We employ a combination of high-throughput RNA sequencing and RBP immunoprecipitation techniques to dissect the molecular interactions between RBPs and splicing machinery. Our findings reveal novel insights into the regulatory networks that govern AS in the context of neuronal cells, highlighting the dynamic nature of splicing regulation and its implications for neural function. The structure of this paper is organized as follows: First, we outline the current knowledge on RBPs and AS, followed by our experimental methodologies. Next, we present our results and discuss their implications in the field of molecular biology. Lastly, we conclude with potential future directions for research in this area.

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