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Exploring the Significance of RNA-binding Proteins: Guardians of RNA Fate

Sisigna Steven*

Department of Bioscience, University of Science and Technology, Macao

DESCRIPTION

RNA, once considered merely a messenger between DNA and proteins, is now recognized as a dynamic player in cellular processes, with its fate tightly regulated by a diverse array of RNA-binding proteins. These RBPs orchestrate post-transcriptional gene expression by modulating RNA metabolism, from splicing and transport to translation and degradation. In this article, we delve into the multifaceted roles of RNA-binding proteins, shedding light on their significance in cellular function and human health. RNA-binding proteins are a diverse group of proteins that interact with RNA molecules through specific RNA-binding domains, facilitating a myriad of RNA-related processes. These RBPs can be broadly categorized based on their modes of action and RNA targets. One of the primary functions of RNA-binding proteins is to regulate RNA stability. By binding to specific RNA sequences or structures, RBPs can either stabilize or destabilize target transcripts, thereby modulating their abundance within the cell. Beyond splicing, RBPs also govern RNA transport and localization within the cell. By binding to specific RNA motifs or forming complexes with molecular motors, such as kinesins and dyneins, RNA-binding proteins facilitate the trafficking of RNAs to subcellular compartments, where they participate in localized translation or other cellular processes. Given their pivotal roles in RNA metabolism, dysregulation of RNA-binding proteins is implicated in various human diseases, including cancer, neurodegenerative disorders, and developmental abnormalities. In cancer, aberrant expression or mutations in RNA-binding proteins can disrupt normal RNA processing pathways, leading to altered gene expression profiles and oncogenic transformation. For instance, mutations in splicing factors, such as SF3B1 and U2AF1, are recurrently observed in hematological malignancies and solid tumors, highlighting the importance of splicing dysregulation in cancer pathogenesis. Mutations in RBPs such as TDP-43 and FUS disrupt RNA metabolism and protein homeostasis, contributing to neuronal dysfunction and degeneration. The dysregulation of RNA-binding proteins in disease settings underscores their potential as therapeutic targets. Efforts to modulate the activity or expression of RBPs hold promise for the development of novel treatment strategies, particularly in cancer and neurological disorders. Small molecules and oligonucleotide-based approaches targeting RNA-binding proteins are being actively explored for their therapeutic potential. For example, small molecules that selectively inhibit splicing factors or disrupt protein-RNA interactions are being developed as anti-cancer agents, aiming to restore normal RNA processing in malignant cells. As our understanding of RNA biology continues to evolve, so does our appreciation of the diverse functions and regulatory mechanisms of RNA-binding proteins. Future research endeavors will focus on elucidating the molecular basis of RBP-RNA interactions, unraveling the spatiotemporal dynamics of RNA metabolism, and exploring the therapeutic potential of targeting RBPs in disease. In conclusion, RNA-binding proteins stand as guardians of RNA fate, exerting precise control over gene expression and cellular function. Their intricate roles in RNA metabolism and their implications in human health and disease highlight the importance of further investigating these versatile proteins. By unraveling the complexities of RBP-mediated RNA regulation, we pave the way for innovative therapeutic strategies and insights into the underlying mechanisms of RNA-related disorders.

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CONFLICT OF INTEREST

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Corresponding author Sisigna Steven, Department of Bioscience, University of Science and Technology, Macao, E-mail: steven-si@gmail.com

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