A Paradigm Shift in Immuno-Oncology

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However, the e cacy of immuno-oncology therapies is not universal, and responses are o en limited by tumor heterogeneity, resistance mechanisms, and immune-related adverse events. Tumors vary greatly in their genetic and molecular makeup, which can impact how they respond to immunotherapy. For instance, certain tumors may have low mutational burdens, making it harder for the immune system to recognize them as foreign. Additionally, some tumors possess intrinsic resistance mechanisms, such as the upregulation of immunosuppressive cytokines or the activation of alternative immune checkpoints, which can prevent immune therapies from being e ective.

e immune response itself is also a double-edged sword. While activating the immune system can e ectively target tumors, it can also lead to immune-related adverse events (irAEs), where the immune system attacks healthy tissues, resulting in autoimmune-like symptoms.

ese side e ects can range from mild symptoms to life-threatening conditions, highlighting the need for careful patient monitoring and the development of strategies to mitigate these risks [7].

e combination of immunotherapy with other treatment modalities o ers a promising strategy for overcoming these challenges. Combining immune checkpoint inhibitors with targeted therapies, such as tyrosine kinase inhibitors, or with radiotherapy, can enhance the immune response while also addressing tumor heterogeneity and resistance. Additionally, the integration of epigenetic therapies and other immunomodulatory approaches could potentially reshape the tumor microenvironment, making tumors more susceptible to immune attack. Another critical area of development lies in biomarker discovery and arti cial intelligence [8]. Identifying predictive biomarkers for response to immunotherapy is crucial for patient strati cation, ensuring that the right patients receive the most appropriate therapies. Biomarkers like PD-L1 expression, tumor mutational burden, and microsatellite instability have shown promise in identifying patients who are likely to