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From microbes to medicine: How microbiota profiling is shaping the future of cancer therapy

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Highlights

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Microbiota profiling stands as a key foundation of precision oncology, connecting microbial composition to cancer diagnosis, progression, and treatment outcomes.

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The combination of next-generation sequencing, metabolomics, and machine learning facilitates in-depth analysis of tumor-associated microbiota and the identification of predictive biomarkers.

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Modulating gut microbiota through approaches like probiotics, synbiotics, or fecal microbiota transplantation holds potential to improve the effectiveness of chemotherapy and immunotherapy.

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The study of the estrobolome and microbial hormone metabolism unveils new opportunities for addressing treatment resistance and refining hormone-driven cancer therapies.

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To advance microbiome-based treatments into clinical use, significant challenges such as methodological standardization, individual variability, and ethical concerns need to be addressed.

Abstract

Microbiota profiling is increasingly recognized as fundamental in advancing personalized cancer therapy. Beyond identifying microbial biomarkers, this review positions microbiota profiling as a dynamic and functional axis in precision oncology capable of both informing patient stratification and being therapeutically modulated to enhance treatment efficacy. By uncovering the dynamics of host-microbiota interactions, it sheds light on their impact on carcinogenesis, tumor progression, and treatment outcomes. This review synthesizes the latest advancements, ongoing challenges, and future directions for microbiome-based strategies in cancer treatment. This study adopts a narrative review approach, synthesizing findings from peer-reviewed articles indexed in PubMed, Web of Science, and Scopus, using a focused search strategy, as detailed in the methodology. The focus centers on microbiota profiling, its roles in cancer therapy, and related therapeutic implications. Microbiota profiling facilitates detailed characterization of microbial ecosystems and their involvement in cancer development and treatment. The next-generation sequencing, metabolomics, and machine learning have enhanced the discovery of microbial

biomarkers. Emerging microbiota-focused interventions, including fecal microbiota transplantation and probiotic therapies, show promise in improving responses to immunotherapy and chemotherapy. However, clinical implementation faces hurdles such as interindividual variability, lack of standardization, and ethical complexities. Microbiota profiling represents a revolution for personalizing cancer treatments. This review synthesizes recent advances in microbiome-focused analytical technologies and examines their implications for cancer diagnosis, treatment, and immune modulation, highlighting key translational opportunities and future directions in oncology.

Section snippets

Introduction to microbiota profiling in cancer research