Microbiomics Integrated with Machine Learning Driving Precision in Female Reproductive Health

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The dynamic interplay between the vaginal microbiome and reproductive physiology has emerged as a critical determinant of maternal health outcomes. Recent advances in bioinformatics and artificial intelligence (AI) are enabling a deeper, systems-level understanding of how microbial communities influence gynaecological and obstetric health. This talk presents an integrated overview of the theoretical underpinnings and real-world applications of microbiome-informed AI approaches in reproductive medicine. We will explore how next-generation sequencing and metagenomic pipelines are leveraged to decode microbial signatures, followed by the application of machine learning algorithms to predict adverse reproductive conditions. Emphasis will be placed on microbial community transitions, immune modulation, and host–microbe crosstalk, interpreted through the lens of computational modelling. Case studies will demonstrate how these techniques are used to stratify risk, identify biomarkers, and support precision diagnostics. The presentation also discusses emerging trends—such as AI, network-based interpretation, and integration with other omics technologies—that are shaping the future of microbiome research. Together, these approaches offer a promising framework for transforming reproductive healthcare from reactive to predictive, with profound implications for early detection and personalized intervention.