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From Bench to Battlefield: Nanobiotechnology and the Real-Time Revolution in Forensic Paternity Testing

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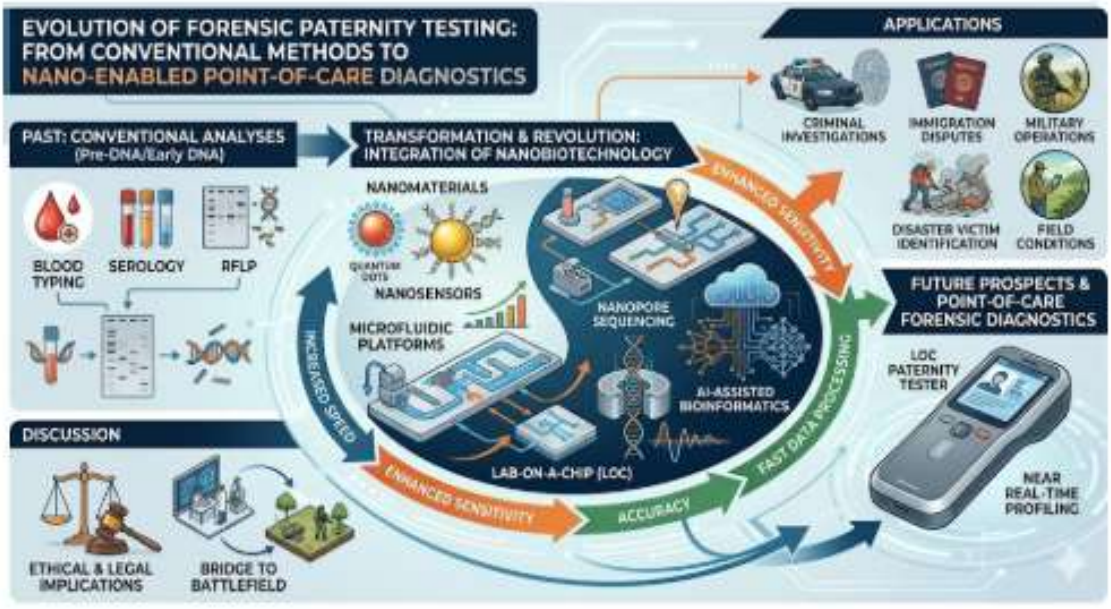
Abstract

Forensic paternity testing has undergone a remarkable transformation from conventional serological analyses to highly sophisticated DNA-based technologies. The integration of nanobiotechnology into forensic genetics has revolutionized the speed, sensitivity, portability, and accuracy of paternity testing. Nanomaterials, nanosensors, microfluidic platforms, lab-on-a-chip devices, nanopore sequencing, and AI-assisted bioinformatics have enabled near real-time genetic profiling in field conditions, military operations, disaster victim identification, immigration disputes, and criminal investigations. This review explores the evolution of forensic paternity testing, highlights the contributions of nanobiotechnology, examines current technologies, discusses ethical and legal implications, and evaluates future prospects toward point-of-care forensic diagnostics. The review emphasizes how nanobiotechnology is bridging laboratory-based analyses and battlefield-ready genetic identification systems.

Graphical abstract



Keywords: Nanobiotechnology, Paternity Testing, Forensic Genetics, Nanopore Sequencing, Biosensors, Real-Time Diagnostics,