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# Development of an Integrated Optical Microfluidic System for Rapid Detection of Antibiotic-Resistant Shigella sonnei

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Nosocomial infections pose a persistent threat to global healthcare systems, affecting millions annually, with reported cases reaching 3.2 million in Europe and 2.5 million in Russia. Among bacterial pathogens, Shigella sonnei—a highly contagious agent linked to severe gastrointestinal illness—remains a critical challenge due to its role in hospital-acquired outbreaks. Rapid, cost-effective detection tools are essential for timely diagnosis and containment. While molecular methods like PCR are widely employed, their reliance on expensive thermal cyclers and complex protocols limits accessibility in resource-constrained clinical settings.

To address the limitations of the traditional PCR method and to utilize the progress made in molecular probe technology, we developed a portable optical microfluidic system leveraging isothermal DNA amplification via the Dual-Priming Isothermal Amplification (DAMP) method and a universal molecular beacon (UMB)-based sensor, designed to detect pathogen-specific DNA sequences and single-nucleotide variations (SNVs) associated with antibiotic resistance. This approach eliminates thermal cycling, enabling target amplification at a constant temperature. The microfluidic chip's closed design minimizes contamination risks, while its portability and compatibility with low-cost spectrofluorometers highlighted its potential for point-of-care deployment.

The microfluidic platform consolidates all analytical stages—sample preparation, amplification, and detection—onto a single chip, contrasting with conventional systems requiring discrete reaction tubes. DAMP amplification was optimized for S. sonnei using primers targeting conserved genomic regions [1]. For detection, a UMB probe was engineered with a sequence-specific binding domain and a quenched fluorophore, enabling fluorescence emission upon hybridization to amplified targets [2]. The UMB's design incorporates a stem-loop structure that discriminates SNVs, ensuring high specificity even in mixed samples.

The system demonstrated robust detection of S. sonnei DNA within 90 minutes, with a sensitivity threshold of 400 copies/$\mu$L. The UMB sensor achieved >95% specificity in identifying SNVs linked to antibiotic resistance.

## References

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2) Sun S.C. et al. Multi-labeled electrochemical sensor for cost-efficient detection of single nucleotide substitutions in folded nucleic acids //Sensors and Actuators B: Chemical. – 2019. – Vol. 287. – P. 569-575.