Machine Learning-Enhanced Silicon nanonet Bio FETs functionalized with DNA aptamers for discrete and real-time monitoring of 17β-estradiol.

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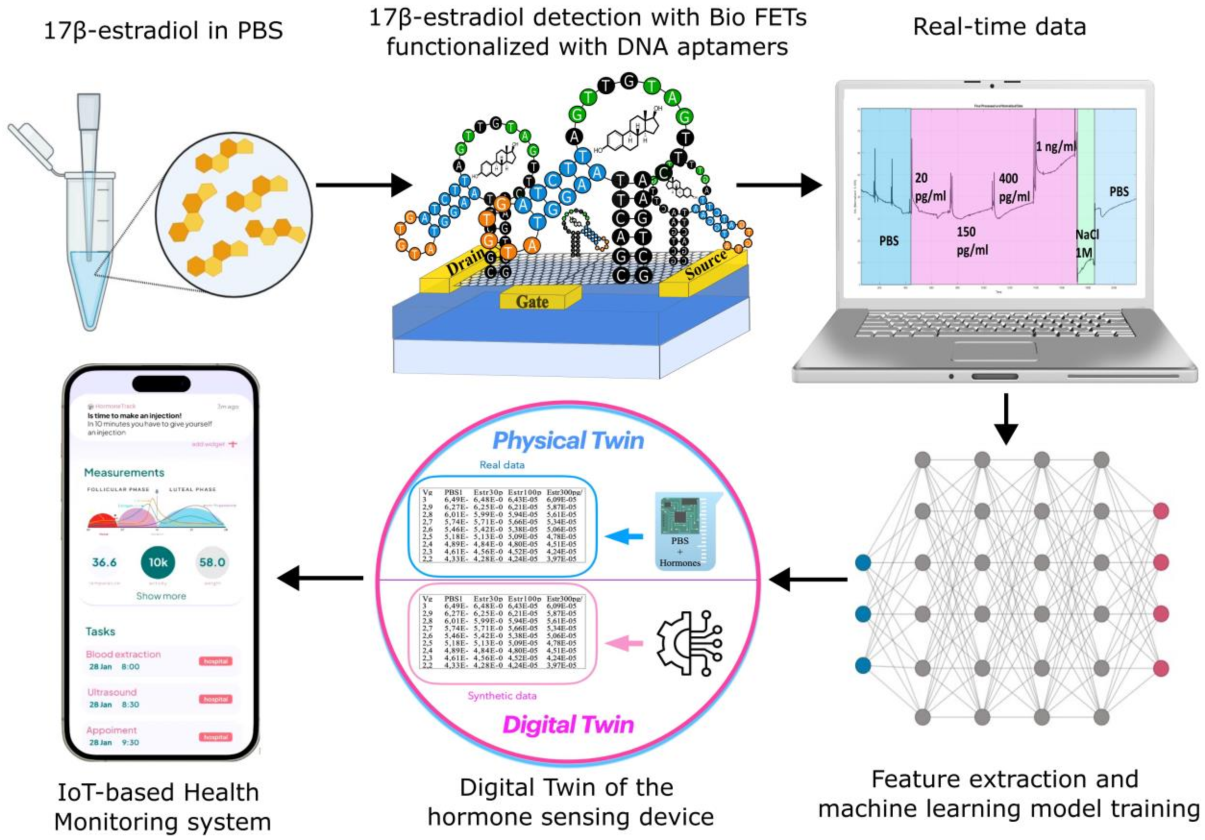

Abstract*

Accurate monitoring of reproductive hormones is essential for diagnosing and managing conditions such as infertility, polycystic ovarian syndrome (PCOS), and hormonal imbalances[1]. Conventional hormone detection methods, such as enzyme-linked immunosorbent assays (ELISAs), while accurate, often require invasive procedures, are costly, and time-intensive. This study investigates the use of silicon nanonet-based field effect transistors (BioFETs)[2] functionalized with DNA aptamers for the real-time and discrete detection of 17β-estradiol, which is considered as a key reproductive hormone.

First, aptamers for 17β-estradiol were immobilized on silicon nanostructures through TESPSA (triethoxysilylpropylamine) silanization. The biosensor was tested by measuring I-V curves with 17β-estradiol concentrations (20, 150, 400, and 1000 pg/mL) in phosphate-buffered saline, simulating hormone levels across menstrual phases. Higher estradiol concentrations led to increased current (Ids) at a constant threshold voltage (1.6 V), attributed to reduced negative field effects from the DNA backbone, facilitating electron flow.

Subsequently, real-time measurements were conducted with Vg set at 1.1 V, showing a corresponding Ids rise with each increase in estradiol concentration. The current level returned to baseline upon adding 1M NaCl, confirming effective estradiol release from the aptamers.

Machine learning analysis of the collected data provided predictive models for estradiol levels, for future enabling of precise, personalized hormone monitoring, which can support infertility treatment by allowing clinicians to track hormonal variations and adjust therapies accordingly.

This study demonstrates the potential of nanomaterial-based BioFETs, enhanced with machine learning, as a powerful tool for both discrete and real-time hormone monitoring, offering new possibilities for reproductive health diagnostics.

Acknowledgements

This work was funded by the DFG project (grant agreement ID: CU44/66-1).

References:

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Keywords

Reproductive hormone monitoring, Nanobiosensors, Silicon nanonet-based BioFETs, Machine learning in biosensing