New Medical Technologies Based on Precision Engineering for Clinical Applications

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Abstract

This presentation will discuss the concept of precision engineering in medicine and present various illustrative examples of this approach. The initial focus will be on **NOAS** (Nanoscale Optical Antennas) within the context of quantitative life sciences and transformative medicine. NOAS enable the visualization of quantum biological electron transfer processes in the mitochondria of living cells. It modulates the electron transfer chain of mitochondria, acting as a ***molecular pacemaker***, and supports the precise release of siRNAs with spatiotemporal accuracy. Additionally, NOAS facilitate the detection of oscillatory communication among living bacteria through extracellular vesicles and create *ultrafast photonic PCR- based* ***molecular diagnostics on chip (iMDx)*** to improve precision medicine. **EXODUS** (Exosome Detection via the Ultrafast- Purification System) is meticulously designed to facilitate accurate diagnostics and therapeutic applications using exosomes. The effective purification of exosomes from patients' liquid biopsies enables comprehensive analyses and advances translational medical treatments. **iTEARS** (Integrated Tear Exosome Analysis via Rapid- Isolation System) allows the detection of protein and miRNA biomarkers, thereby enhancing the diagnostic capability for various diseases through the analysis of tear samples. **BOAS** (Brain Organoid Analysis System), which integrates biosensors and EEG for real- time, non- invasive monitoring of brainwaves and extracellular vesicles (EVs), was developed to explore the connections between molecular signals and neurophysiological brainwaves. This study critically analyzes and offers insights into the interrelationships among secretomes, electrophysiological brainwaves, and the networks generated from human brain organoids. The in vitro models of BOAS serve as valuable tools for researchers investigating neuropathogenesis, developing treatments for neurodegenerative diseases, and exploring preventive medical therapies by studying the interactions between EVs and brainwaves. Furthermore, the precision engineering in medicine initiative aims to develop solutions for preventive and personalized medicine that contribute to affordable and efficient healthcare.