

# Precision Medicine at the Nanoscale:

## The role of Nanoparticle-Protein Corona in Diagnostics

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Recent advances in nanotechnology and bio-nano interactions have opened new avenues for cancer diagnostics. Nanoparticles (NPs) exposed to biological fluids rapidly acquire a biomolecular layer known as the protein corona (PC) [1]. Over the past 15 years, it has become clear that PC formation results from a complex interplay between NP physicochemical properties, biological fluid composition, and environmental factors. Importantly, the PC does not simply reflect the human proteome but represents a personalized molecular fingerprint associated with an individual's biological and pathological state. This offers the opportunity to enrich low-abundance disease-associated biomolecules that may escape conventional detection.

Over the past decade, our research has translated this concept into Nanoparticle-Enabled Blood (NEB) tests, exploiting disease-specific PC signatures for patient discrimination. Starting from pancreatic ductal adenocarcinoma [2], we systematically investigated nanomaterials, experimental conditions, and complementary analytical technologies, including SDS-PAGE, mass spectrometry, dynamic light scattering, fluorescence lifetime analysis, and vibrational spectroscopy [3,4]. The platform was subsequently extended to other pathological conditions, including brain tumors and neurodegenerative diseases, supporting its versatility across different clinical settings.

More recently, we have moved from single nanotechnology-derived readouts toward multiplexed diagnostic strategies [5], integrating PC-derived fingerprints with complementary technological outputs and clinical parameters through machine-learning approaches. This evolution toward multidimensional data integration may improve patient stratification and diagnostic performance, paving the way for translating personalized protein corona signatures into robust precision nanodiagnostic tools.

### Reference

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