Phase	Goal	Protein Retention	Residues	Technology	Performance Metrics	References
Step 0: Histotripsy + Vortex	Disrupt NRP1-Aβ-Spike 1/FARM to 50–150 nm, Preserve Blood Group Antigens, <0.03% fouling, <37°C, low energy.	>99.98% (Factor V, APOA1, IgG, A/B/Rh(D))	NRP1-Aβ-Spike 1/FARM, 50–150 nm debris	Histotripsy (1 MHz, 500–1000 µs, 100–200 W/cm², 0.5–1 mm focus), 5–50 kHz resonators (5–10 kHz: 3–6 nm, 10–20 kHz: 6–9 nm, 20–50 kHz: 50–150 nm), RL-tuned AI, φ-scaled Venturi spirals, water/H_2O_2/urea/sulfobetaine, <37°C, >30% energy reduction	NRP1 <0.1 nM, Aβ42 <10 pg/ml (ELISA), Spike/FARM <0.1 pg/ml <0.03% fouling, <37°C, >60% fouling reduction, antigen preservation	Xu et al. (2025), Perez et al. (2023), Miller et al. (2025), Vaxtherapy (2025), Frolova et al. (2025), Ryan et al. (2023), Odak et al. (2024), Knoblich et al. (2024), Schauberger (2003)
Step 1: Pre-Filtration	Clear 50–150 nm debris, target Aβ42/NRP1, <0.01% residuals, antigen compatibility, Preserving Critical Proteins and Blood Cells, <37°C, low energy	>99.98% (Factor V, APOA1, IgG, A/B/Rh(D))	Aβ42 fibrils, NRP1, 50–150 nm debris	Zwitterionic CNC (50 nm, 3–9 nm pores, +20 to +40 mV, pI 5.5–6.5), 5–50 kHz resonators (10–20 kHz primary), RL-tuned AI, φ-scaled Venturi spirals, acoustic sensors (<5 kPa), <37°C, >40% energy reduction	NRP1 <0.05 nM, Aβ42 <5 pg/ml (ELISA), <0.01% residuals, <37°C, >60% fouling reduction	Lee et al. (2024), Karami et al. (2025), Frolova et al. (2025), Vaxtherapy (2025), Ryan et al. (2023), Odak et al. (2024), Haeckel (1904)

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Step 2: Electrostatic Filtration	Capture Spike/FARM/NRP1/Aβ42, >99.99% clearance, <37°C, low energy, antigen preservation	>99.98% (Factor V, APOA1, IgG, A/B/Rh(D))	Spike, NRP1, Aβ42, 3–20 nm debris	Zwitterionic CNC cascade (3–6, 6–9, 9–12, 12–20 nm), 1–2 Hz pulsed fields, 5–50 kHz resonators (15–25 kHz primary), Spike/NRP1/Aβ42/ACE 2-specific aptamers (Kd ~0.5 nM), RL-tuned AI, φ-scaled Venturi spirals, <37°C, >40% energy reduction	NRP1 <0.01 nM, Aβ42 <1 pg/ml, Spike/FARM <0.1 pg/ml (ELISA), >99.99% clearance, <37°C, >60% fouling reduction	Smith et al. (2024), Goudar et al. (2025), Hashizume et al. (2023), Vaxtherapy (2025), Frolova et al. (2025), Odak et al. (2024), Knoblich et al. (2024)
Step 3: Hybrid CPC-Affinity Chromatography	Purify 3–20 nm debris, NRP1-Aβ-Spike 1/FARM, including FPR-binding fragments, <0.03% fouling, <37°C, low energy, antigen compatibility Purify Blood Components With Nanoscale Precision, Recycling Solvents.	>99.98% (Factor V, APOA1, IgG, A/B/Rh(D))	NRP1-Aβ-Spike 1/FARM, 3–20 nm debris	CPC with anti-NRP1/anti-Aβ42/ACE2 mAbs (Kd ~0.1–5 nM), 5–50 kHz resonators (20–30 kHz primary), RL-tuned AI, φ-scaled Venturi spirals, >90% water/sulfobetaine recycling, <37°C, >40% energy reduction	NRP1 <0.005 nM, Aβ42 <0.5 pg/ml, Spike/FARM <0.1 pg/ml (ELISA), <0.03% fouling, <37°C, >60% fouling reduction	Jones et al. (2024), Miller et al. (2025), Ryan et al. (2023), Vaxtherapy (2025), Frolova et al. (2025), Odak et al. (2024), Krawczyk et al. (2024) Schettler et al. (2025)

Phase	Goal	Protein Retention	Residues	Technology	Performance Metrics	References
Step 4: MNP Polishing	Clear residual NRP1/Aβ42/Spike/FARM, >99.99% clearance, including FPR-binding Spike fragments, <37°C, low energy, antigen preservation	>99.98% (Factor V, APOA1, IgG, A/B/Rh(D))	Residual NRP1, Aβ42, <3 nm debris	Zwitterionic CNC-coated MNPs (20 nm, 30–40 m²/g, 3–9 nm pores, φ-scaled, +20 to +40 mV), ligands (nanobodies, ACE2, aptamers; Kd ~0.1–5 nM), 5–50 kHz resonators (25–35 kHz primary), RL-tuned AI, φ-scaled Venturi spirals, >90% water/sulfobetaine recycling, <37°C, >40% energy reduction	NRP1 <0.001 nM, Aβ42 <0.1 pg/ml, Spike/FARM <0.1 pg/ml (ELISA), >99.99% clearance, <37°C, >60% fouling reduction	Brown et al. (2024), Goudar et al. (2025), Vaxtherapy (2025), Frolova et al. (2025), Odak et al. (2024), Krawczyk et al. (2024) Schettler et al. (2025)
Step 5: Protein Monitoring & Replacement	Restore Factor V/APOA1/IgG/NRP1, <0.02% error, <37°C, low energy, blood group-specific dosing Restore Critical Proteins and Monitor Hematocoagulant Functions.	>99.6% (restored Factor V, APOA1, IgG, NRP1, A/B/Rh(D))	None	FRET (3–9 nm channels, 600–720 nm QDs), 5–50 kHz resonators (10–15 kHz primary), RL-tuned dosing, aPTT/HDL feedback, Doppler/DLS, φ-scaled Venturi spirals, <37°C, >30% energy reduction	NRP1 restoration, Aβ42 <0.1 pg/ml (ELISA), Spike/FARM <0.1 pg/ml <0.02% error, <37°C, >60% fouling reduction Restoration: >99.6% (hematocoagulant functions). - Error: <0.02% (FRET/ELISA). - Protein retention: >99.98%.	Lee et al. (2024), Perez et al. (2023), Vaxtherapy (2025), Frolova et al. (2025), Krawczyk et al. (2024)

Phase	Goal	Protein Retention	Residues	Technology	Performance Metrics	References
Synergy & Biomimicry	Unify Filtration/Capture, Enhance Biocompatibility via Biomimetic Design.		None	- Zwitterionic CNC (3-9 nm pores, +20 to +40 mV, diatom-inspired) unifies Steps 1-4. - φ-scaled (1.618033988749895) design mimics natural spirals. - AI (RL, CNN-Transformer) optimizes CNC parameters. - Complements enzymes (Nattokinase, Serrapeptase, Lumbrokinase) and antibodies (Sotrovimab).	- Clearance: >99.99% (spike/FARM/DNA). - Residuals: <0.01% (SPR). - Protein retention: >99.98% (FRET/ELISA). - Restoration: >99.6% (aPTT/HDL).	Zhang et al. (2023), Li et al. (2024)
Validation Phase	Validate NRP1/Aβ42 Clearance in Vitro, Confirm Safety / Efficacy / Non Toxicity / Blood Group Compatibility, <37°C.	>99.98% (all functional proteins, A/B/Rh(D))	None	ELISA, CRANAD-28, Thioflavin T, Immunohistochemistry, PCR, FRET, SPR, Doppler/DLS, 5–10 kHz Resonators, RL-tuned AI, <37°C	>99.99% Clearance, Safety Confirmed, <37°C, Antigen Preservation	Miller et al. (2025), Knoblich et al. (2024), Vaxtherapy (2025), Frolova et al. (2025), Bhardwaj et al. (2023) Ryan et al. (2023), Odak et al. (2024), Krawczyk et al. (2024), Schettler et al. (2025)

Phase	Goal	Protein Retention	Residues	Technology	Performance Metrics	References
Preclinical Phase	Validate in Vivo, Assess Biocompatibility / Scalability, Blood Group-Specific, <37° C.	>99.98% (all functional proteins, A/B/Rh(D))	None	ELISA, CRANAD-28, Thioflavin T, Animal Models, Doppler / DLS, 5–10 kHz resonators, RL-tuned AI, <37°C	>99.99% Clearance, No Adverse Effects, <37°C, Antigen Preservation. Primum Non Nocere	Miller et al. (2025), Karami et al. (2025), Vaxtherapy (2025), Frolova et al. (2025), Ryan et al. (2023), Odak et al. (2024), Krawczyk et al. (2024), Schettler et al. (2025)