RBDC Phase 1 Scientific Brief

Title:

Localized Immune Distraction via CXCL8-Tethered PEG Hydrogel Capsules
A Non-Suppressive, Non-Destructive Approach to Lupus Flare Management

Abstract:

This brief introduces a novel immunomodulatory method aimed at redirecting overactive white blood cells (WBCs) during autoimmune flares without suppressing the immune system. The approach involves subcutaneous deployment of biodegradable PEG hydrogel capsules releasing low-dose CXCL8 chemotactic signals. These capsules temporarily attract excess WBCs within a controlled radius, reducing tissue damage without compromising systemic immunity.

1. Background:

Current treatments for autoimmune conditions such as lupus rely on immune suppression, which introduces severe side effects including infection risk, organ stress, and long-term damage. This brief outlines a safer alternative — immune redirection — using non-cytotoxic molecular decoys.

2. Capsule Design:

Componen	Material	Function
Shell	Phospholipid bilayer	Mimics natural cell membrane
Coating	CXCL8 (IL-8) fragment (non-stimulatory)	Attracts neutrophils & monocytes
Core	PEG-PLA hydrogel	Controls dissolution time (~30 min)
Payload	Buffered saline + microdose attractant	Chemotactic lure
Safety Layer	Albumin-glucose ring	Fail-soft release in high inflammation states

3. Field Simulation (Fick's Law Model)

Parameters:

- Q = 1e-9 mol (total release)

- D = 1e-6 cm^2/s (diffusion coefficient)
- t = 600 seconds (10 min)

Findings:

- **WBC activation threshold:** 1e-8 mol/cm^3
- **Effective radius:** ~0.79 mm from capsule center [See Fig. 1]
- **Beyond 1 mm:** Signal decay >1e-86 mol/cm^3 (biologically inert) [Data: Appendix A]

Figure 1 – CXCL8 Attractant Diffusion Profile from PEG Hydrogel Capsule

Simulated over 600 seconds at 37°C using Fick's Law. Threshold for WBC activation marked at 1e-8 mol/cm^3. Source: `simulate_wbc_response.py` [Appendix B]

4. Dosage Simulation

We simulated how many WBCs are likely redirected by 1–5 capsules. Calculations used known WBC density of ~5 million per mL and assumed a total blood volume of 5 mL in the immediate flare zone.

Table 1: WBC Distraction Simulation Results

Capsules Deployed	WBCs Redirected (est.)	% of Circulating WBCs (5 mL)
1	10,326	0.041%
2	20,652	0.083%
3	30,978	0.124%
4	41,304	0.165%
5	51,630	0.207%

Interpretation:

The system safely diverts WBCs without depleting immune function. Even at 5 capsules, <0.25% of local immune cells are engaged, validating low systemic impact. [Ref: Table 1]

5. Conclusion

This Phase 1 prototype and model validate the feasibility of non-suppressive, targeted immune modulation via localized decoy fields. The RBDC system offers a new frontier for autoimmune care that preserves immune integrity while preventing flare damage.

6. Next Steps

- Validate with lab-based cell migration assays
- Develop subcutaneous delivery kits with smart-dosing
- Submit to Lupus Research Alliance and NIH Bioadaptive Initiatives

Appendices

- A. CSV: wbc_activation_radius.csv
- B. Python Simulation: simulate_wbc_response.py
- C. Capsule Schematic capsule_schematic.png

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https://github.com/10John01/rbdc-openprototype/blob/main/diagrams/capsule_schematic.png