DREXEL UNIVERSITY
School of
Biomedical Engineering,
Science and Health Systems

Development and Optimization of GelMA Hydrogels for Controlled Dual-Drug Release in Chronic Wound Healing

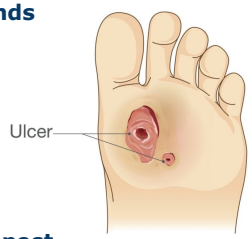
Eva Elizabeth Kraus[1], Kara L. Spiller, PhD[1]
[1]School of Biomedical Engineering, Science & Health Systems, Drexel University

PROBLEM & NEED

Issue of Geriatric Diabetic Wounds

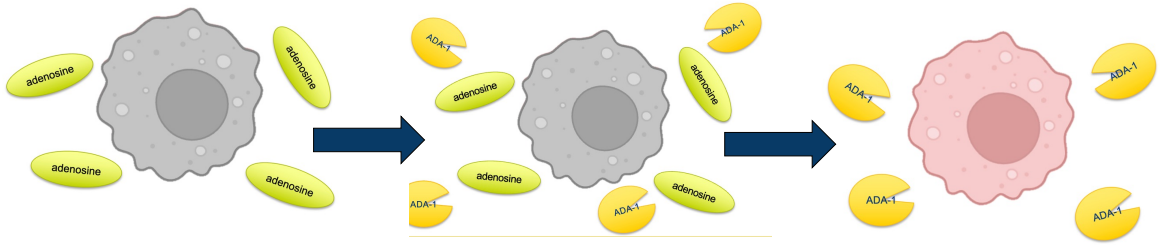
- **Affect 2.5% of U.S. population**
  - 10.5 million patients
- **Can lead to:**
  - Systemic infection
  - Multi-organ dysfunction
  - Amputation
  - Death[1]

27% survival rate 5 years post amputation[2]



Hyporesponsive macrophages lose their inflammation capacity

Need additional support from artificially introduced cytokines and proteins to restore immune function



GOAL

To co-deliver IFN-γ and ***ADA-1*** to enhance wound healing by inducing a pro-inflammatory environment and ***rescuing the diminished immune response***

DESIGN INPUTS

Requirements

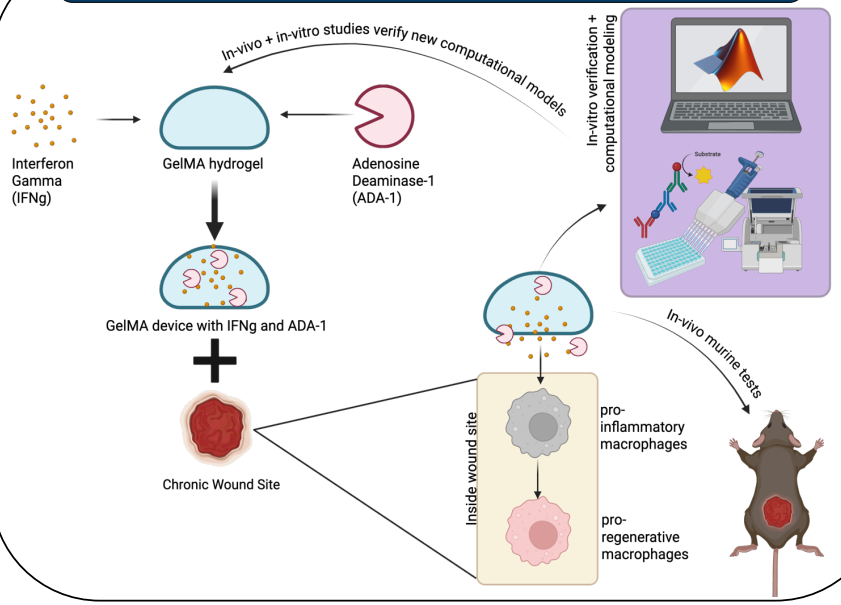
- **(R01)** Delivery of ≥100 ng IFN-γ in 2 days
- **(R02)** Delivery of ≥21.5 µg ADA-1 in 2 days
- **(R03)** Hydrogel handleability
- **(R04)** Clinically usable geometry (1–10 cm²)

Objective: Murine-scale model recommendation for in-vivo testing for 4 days w/ 200 ng IFN-γ

Constraints

- **Material** → GelMA due to lab expertise
- **Resource** → Time, budget, & availability of resources
- **Experimental** → Adherence to experimental protocols and availability of verification tools

DESIGN + VERIFICATION



CONCLUSIONS

- **GelMA hydrogels enable tunable, sustained IFN-γ delivery.**
  - ADA-1 delivery remains a challenge for dual-drug systems.
- **Hydrogel properties significantly impact cytokine release.**
- **Computational modeling validates and optimizes drug release profiles.**
  - Predictive model provides a valuable tool for hydrogel design
- **Foundation laid for in-vivo testing in chronic wound models.**

ACKNOWLEDGEMENTS

A special thank you to my faculty advisor, Dr. Kara Spiller and my mentor, Samuel Sung, MS. I would also like to thank the entire Biomaterials and Regenerative Medicine Laboratory team for providing this opportunity and supporting me during this thesis research journey.

References: [1] Sen, C. K.. (2023). Human Wound and Its Burden: Updated 2022 Compendium of Estimates. Advances in Wound Care, 12(12), 657–670. https://doi.org/10.1089/wound.2023.0150 [2] Jupiter, D. C., Thorud, J. C., Buckley, C. J., & Shibuya, N. (2016). The impact of foot ulceration and amputation on mortality in diabetic patients. I: From ulceration to death, a systematic review. International wound journal, 13(5), 892–903. https://doi.org/10.1111/iwj.12404