



BioBand: An Early-Warning Continuous Monitoring System for Infected Wounds

Joshitha Pilla, Meilene Hanaki, Kelzzy Buenaventura, Melanie Adjei
Johns Hopkins University | Whiting School of Engineering | Baltimore, MD



Motivation & Market

Motivation

~11x higher mortality risk increases when SSI's are detected late and affects 11 out of 100 surgical patients

Currently, there are no low-cost bandages that offer continuous wound monitoring and early infection detection without removal of bandage

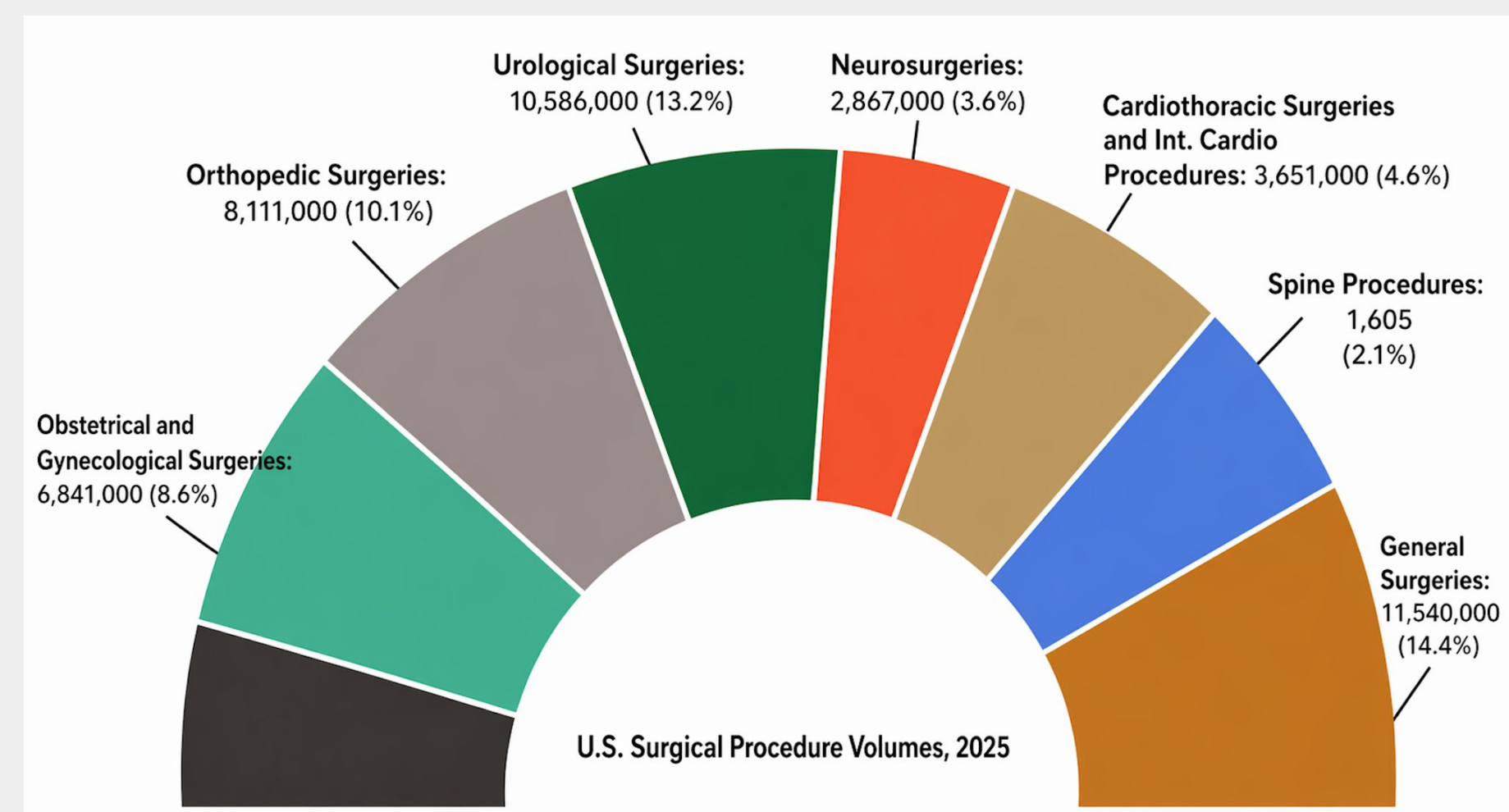


Figure 1: U.S. Surgical Procedures Volume, 2025

- 24-32M annual addressable procedures
- 14-15M initial high-risk target market
- 5% adoption = 700K+ uses/year

Product Design

Biological Basis: Infected, chronic wounds are characterized by an alkaline environment, with pH above 7.5. We propose **BioBand**, a highly-absorbent hydrogel loaded with pH-responsive dye, as an affordable, easy-to-use solution that provides continuous-monitoring for early infection detection

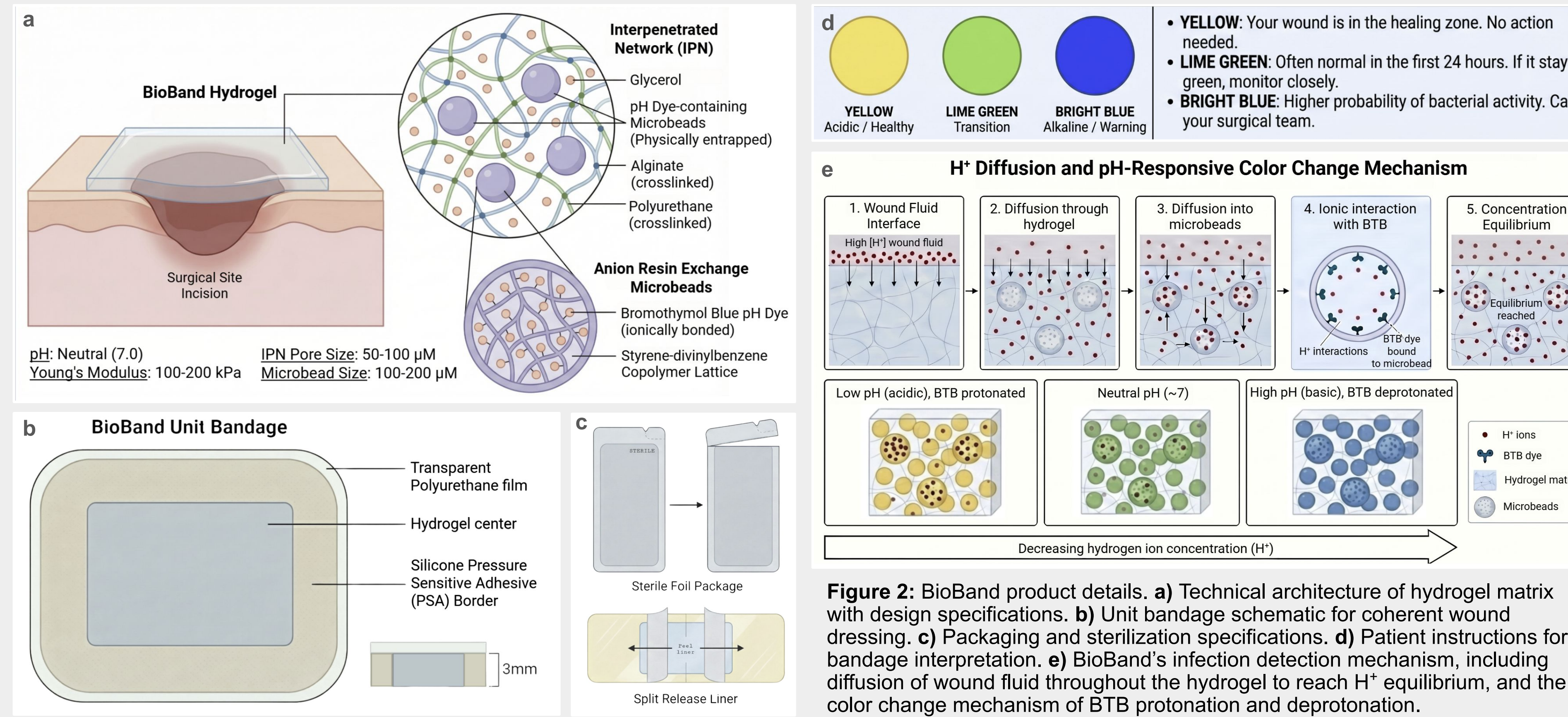


Figure 2: BioBand product details. a) Technical architecture of hydrogel matrix with design specifications. b) Unit bandage schematic for coherent wound dressing. c) Packaging and sterilization specifications. d) Patient instructions for bandage interpretation. e) BioBand's infection detection mechanism, including diffusion of wound fluid throughout the hydrogel to reach H⁺ equilibrium, and the color change mechanism of BTB protonation and deprotonation.

Financial Analysis

a Estimated Costs

Cost Type	Duration	Cost
R&D	Year 1-3	\$3.8M
Capital	Year 1	\$86.5K
Operating	Year 3+	\$932.5K
Business	Year 3+	\$570K

b NPV Over 6 Years

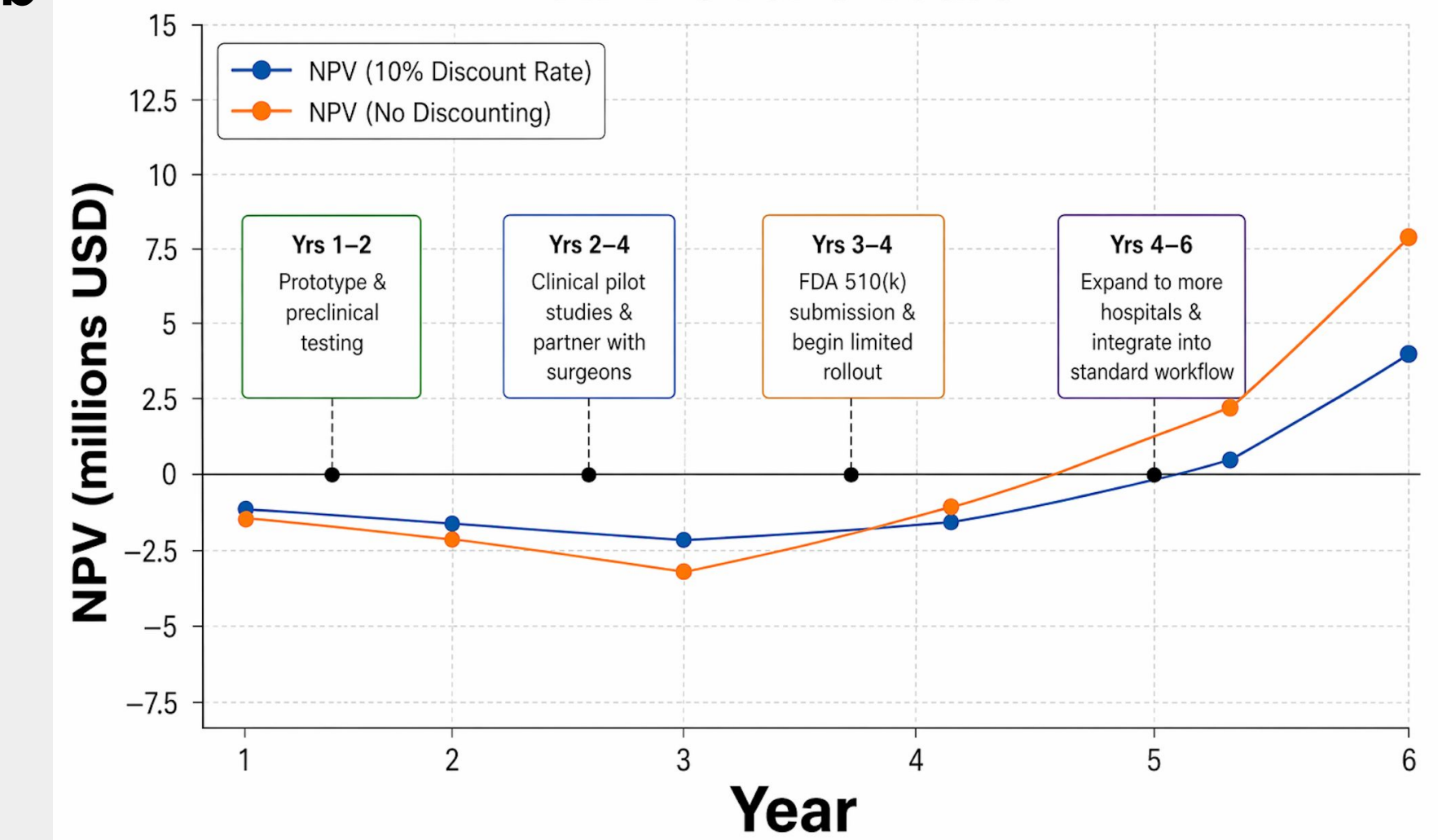


Figure 7: Financial analysis of the proposed development and manufacturing of BioBand. An itemized list of costs and their duration is presented in table a) b) uses this information to determine the net present value (NPV) over time

- **Market Price:** \$18 (small), \$20 (standard), \$23 (large)
- **Variable Production Scale:** 50K (Year 1), 100K (Year 2), 250K (Year 3), 500K (Year 4), 750K (Year 5), and 1M (Year 6+)
- **3 years of R&D**
- Operating costs begin in **Year 3** and increase **5% annually**
- Business (marketing) costs begin in **Year 3**
- Discount rate (WACC): **10%**
- Break-even achieved in **5 years**

References & Acknowledgements

This research was supported by the Johns Hopkins Chemical and Biomolecular Engineering Department. Special thanks to Dr. Josephson, Dr. Farias, Dr. Gracias, and Shreya Ramesh for their guidance, support, and advice.



References

Manufacturing Process

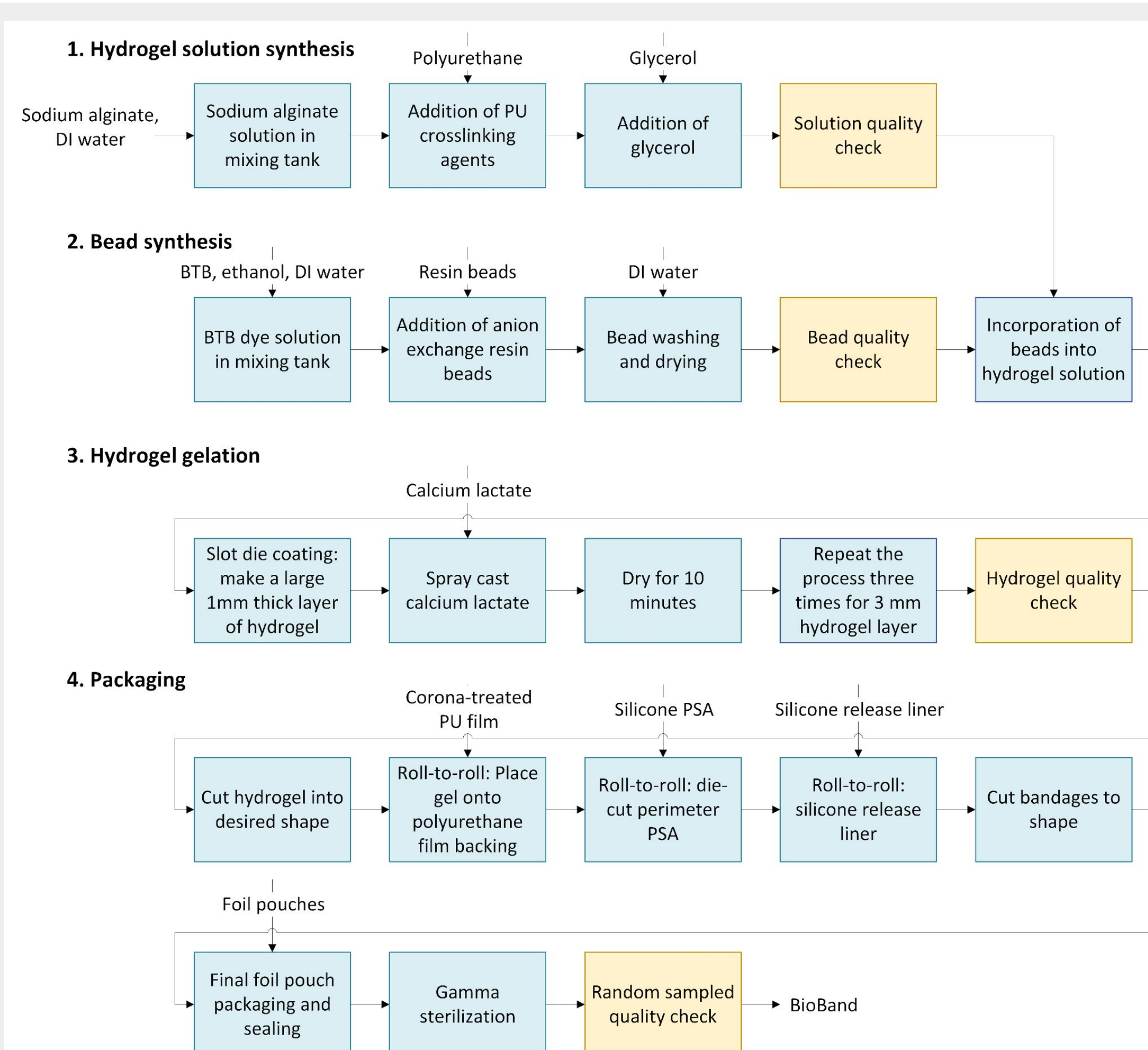


Figure 3: Manufacturing block diagram for BioBand.

Process Modeling



Figure 4: Diffusion modeling of hydrogen ions based on distance. a) 1D Fickian diffusion through hydrogel. b) Fickian spherical diffusion through resin beads.

Figure 5: Expected color change of BTB dye based on pH.

Market Launch Timeline

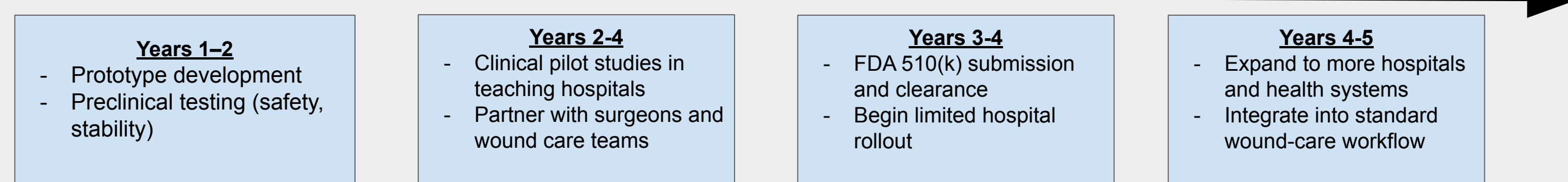


Figure 6: Projected timeline showing BioBand development, regulatory approval, and adoption in hospital settings



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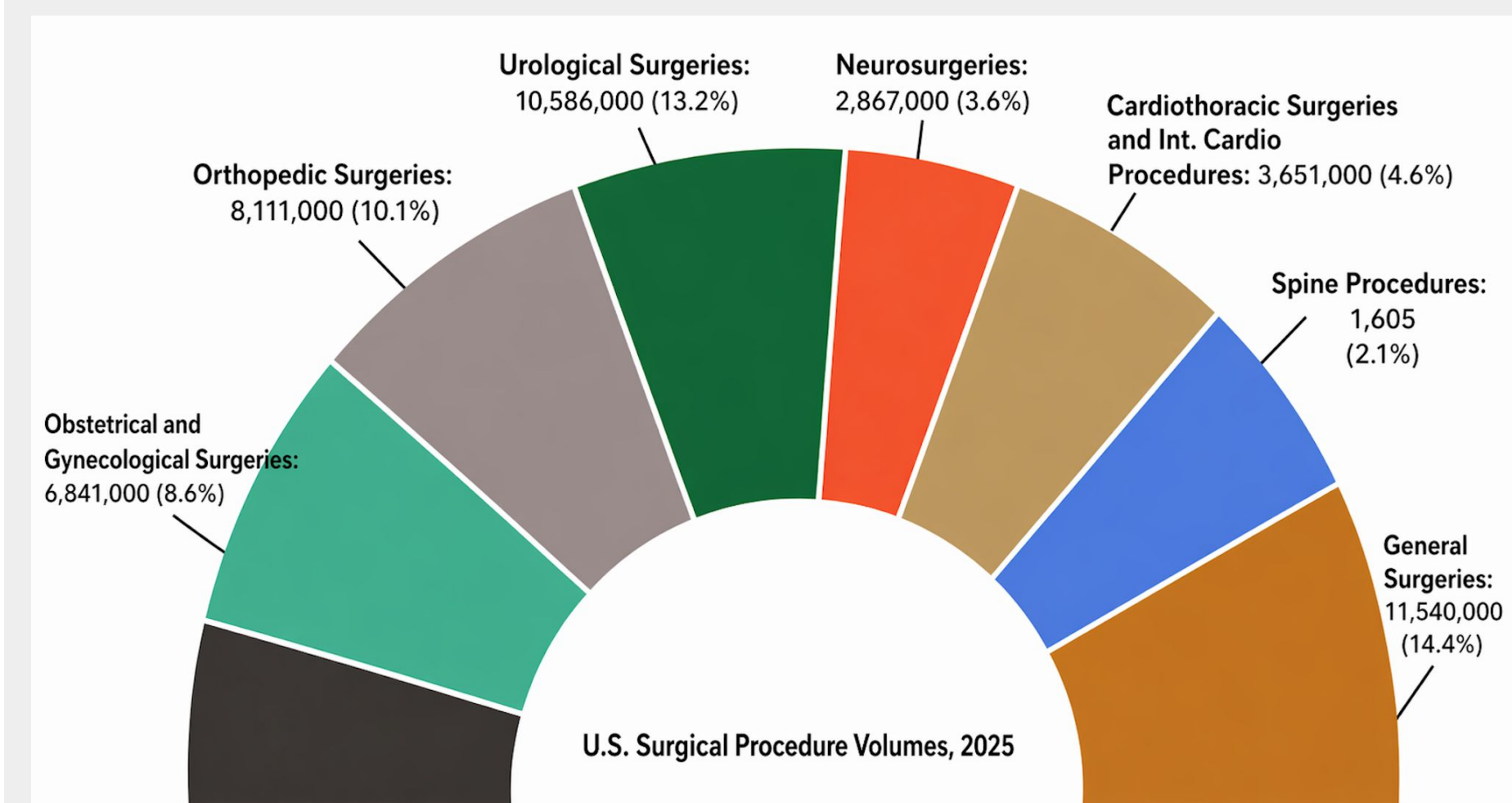


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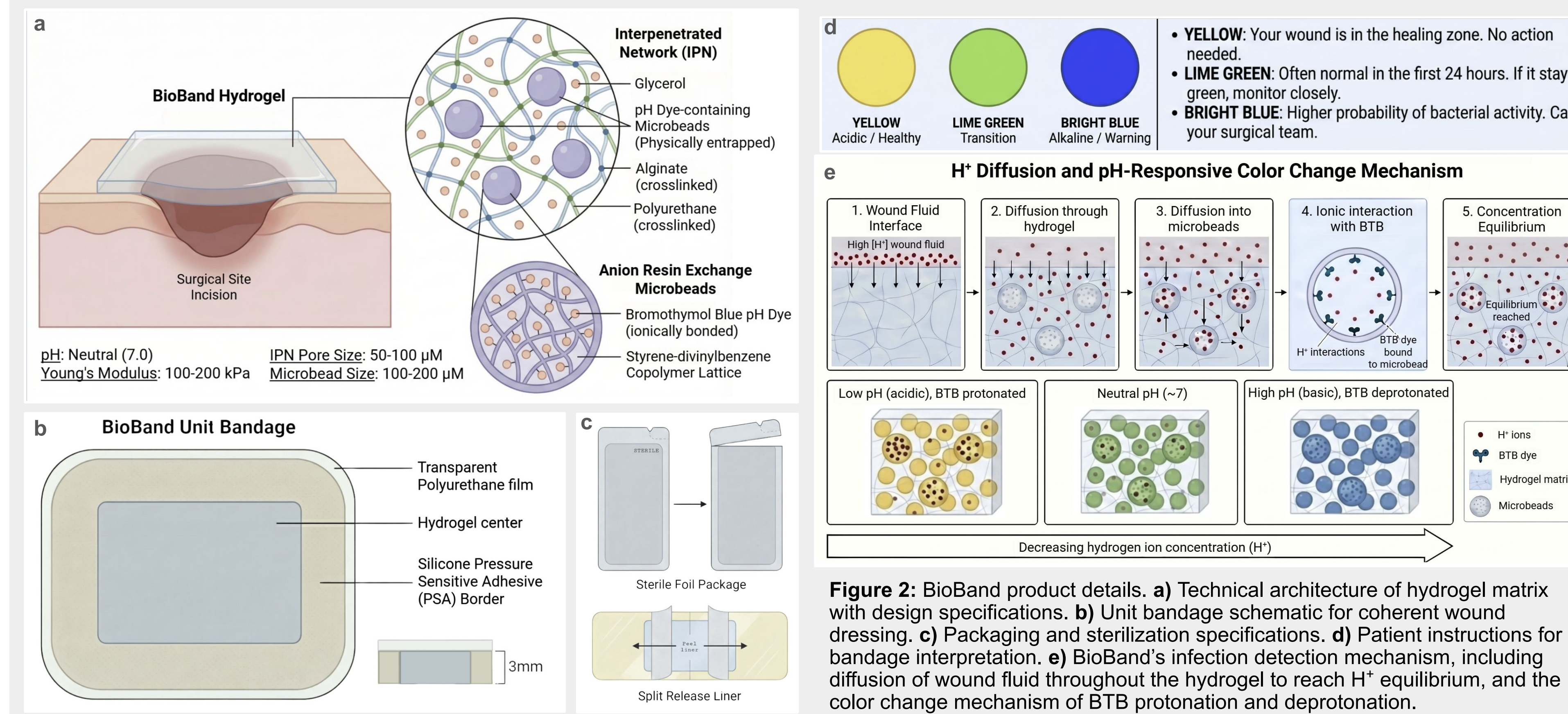


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NPV Over 6 Years

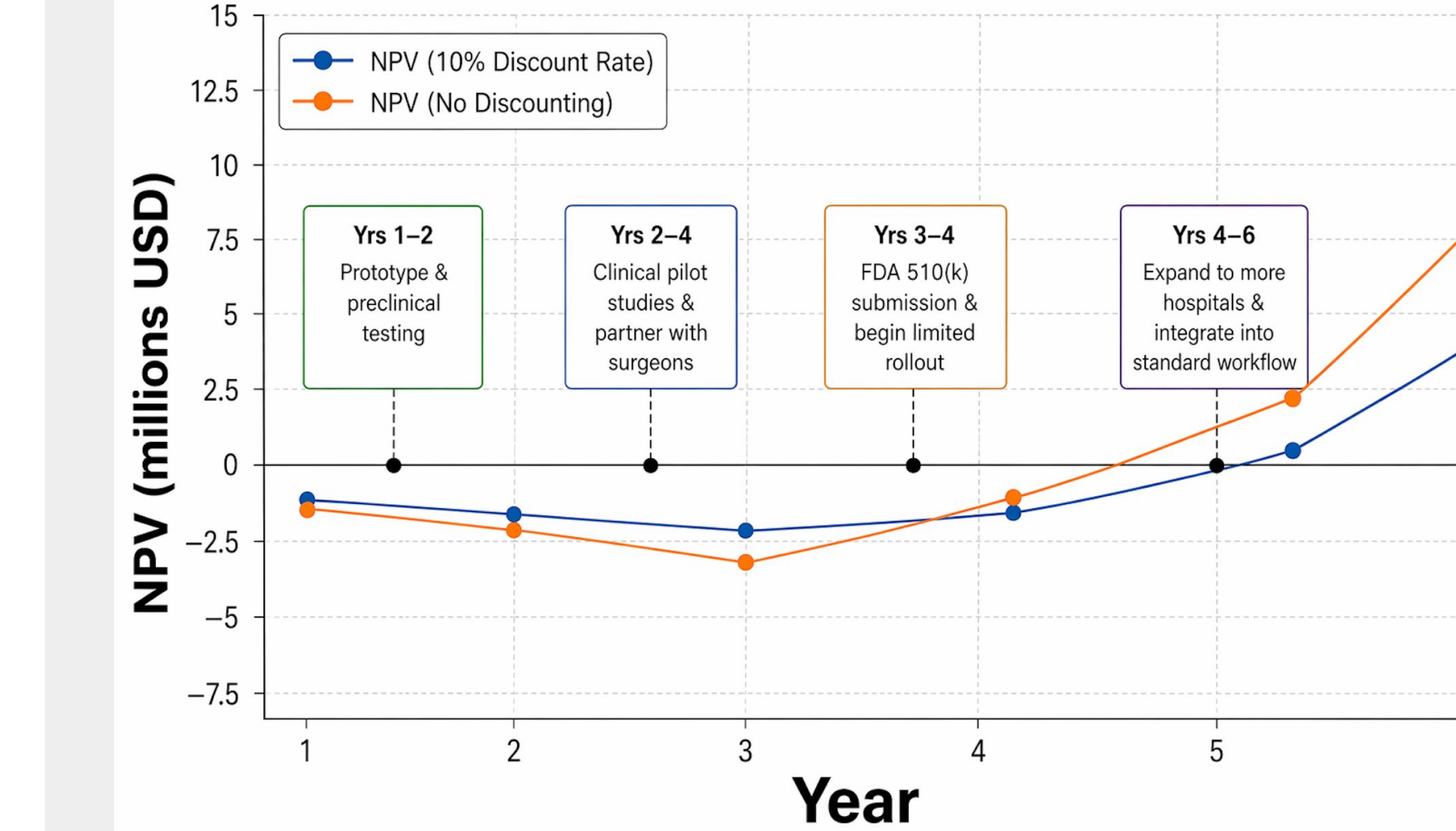
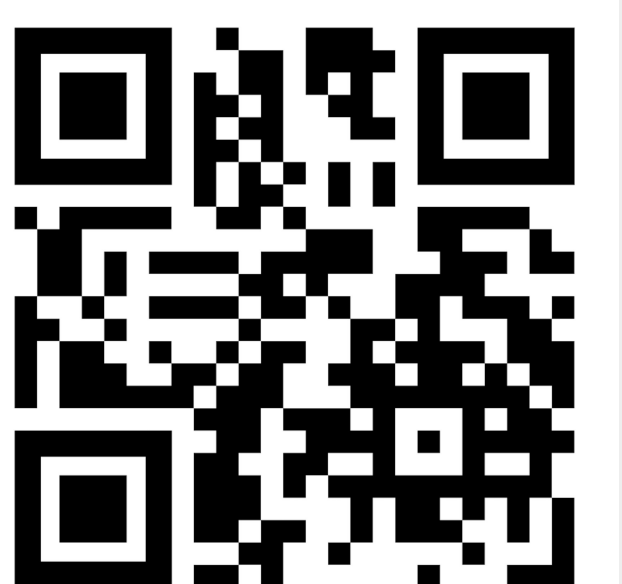


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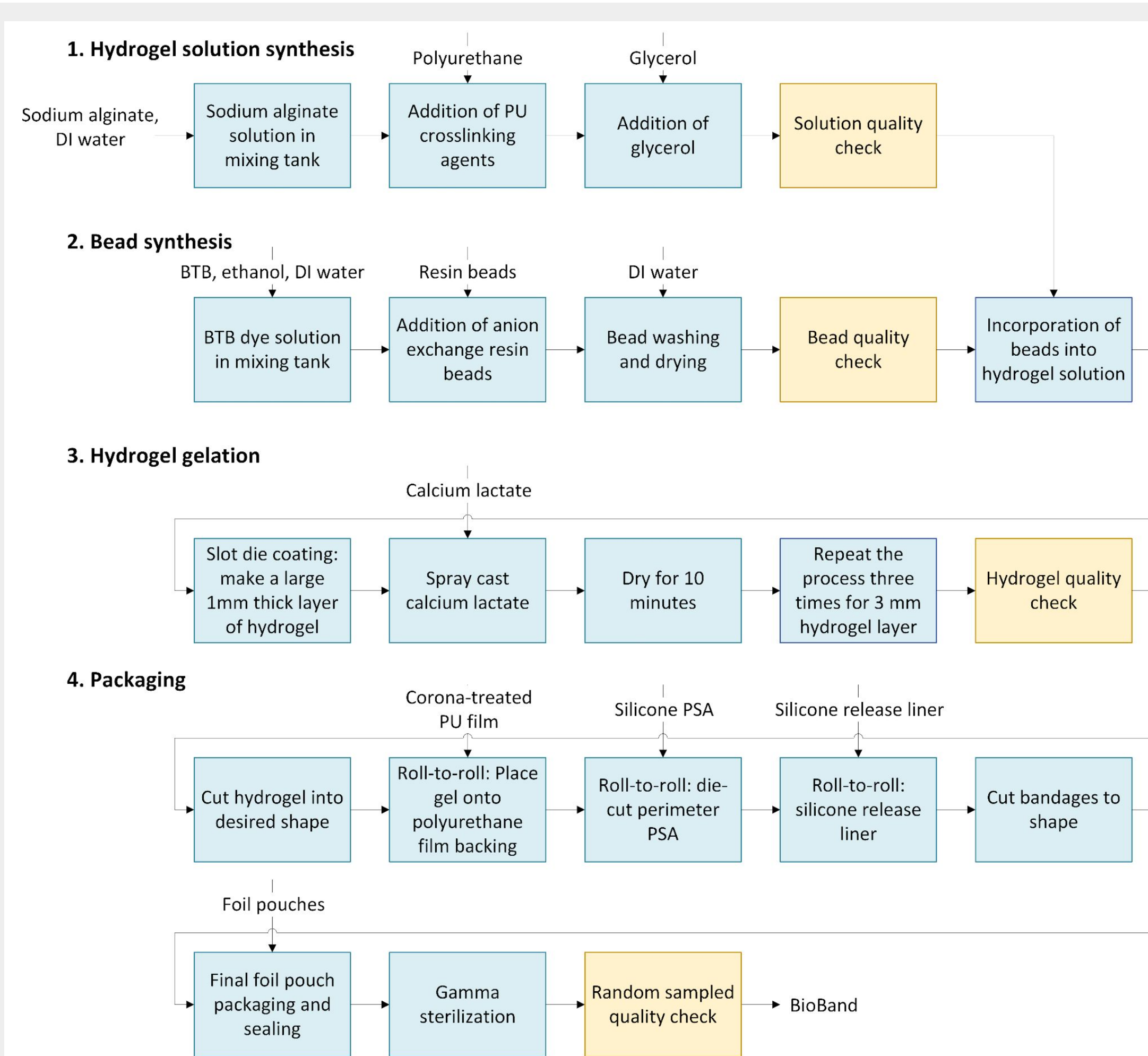


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Process Modeling

Real-time continuous monitoring of wound bed is facilitated by diffusion of wound fluid through hydrogel and microbeads and subsequent achievement of H⁺ equilibrium with the pH dye.

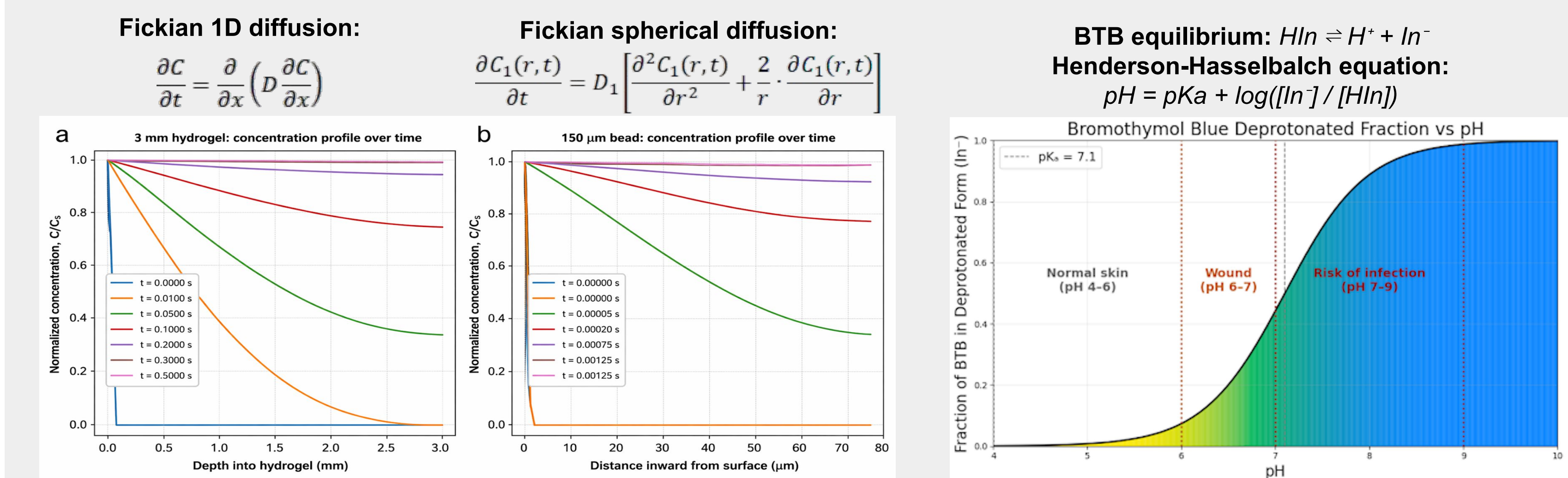


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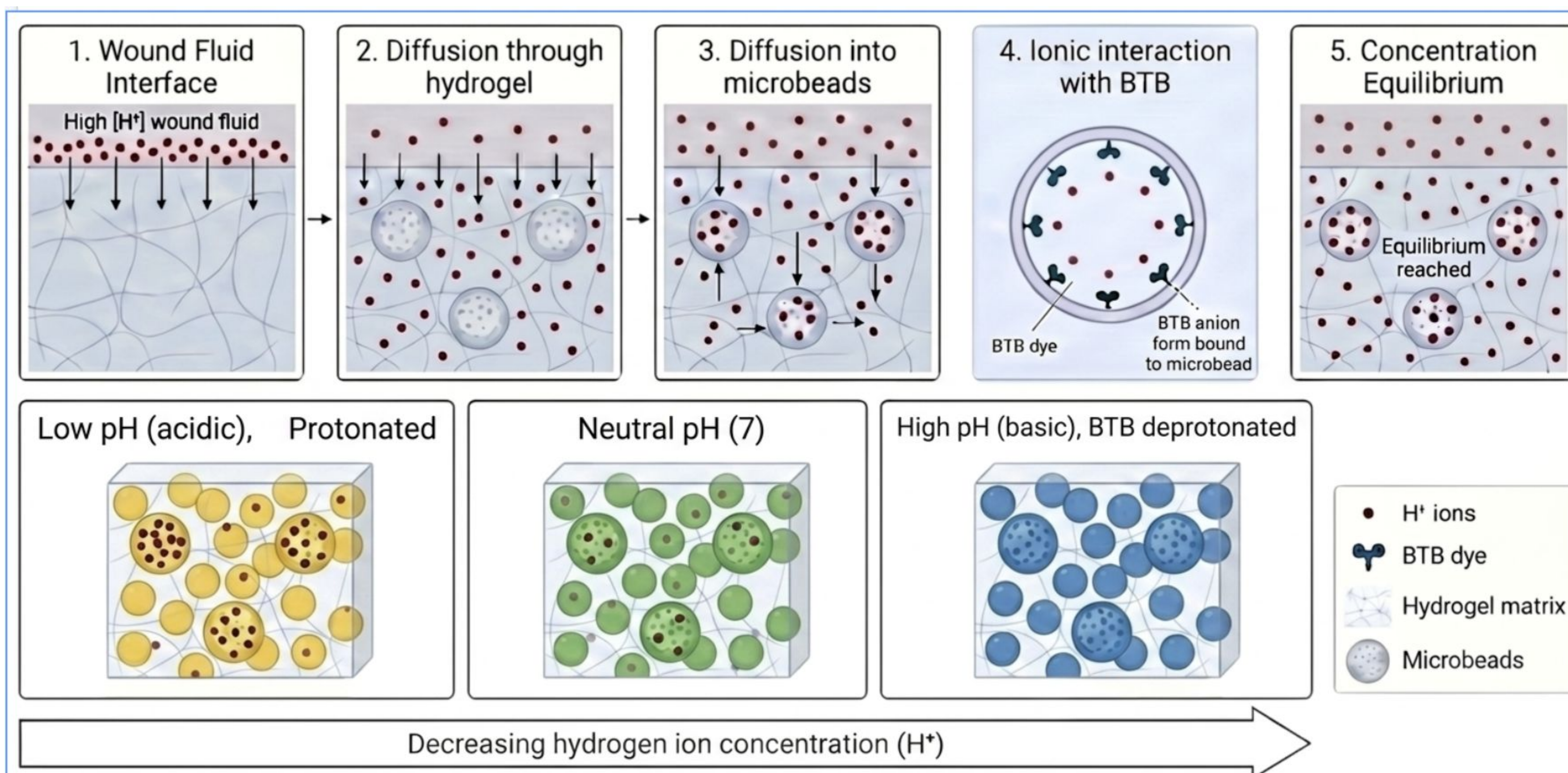
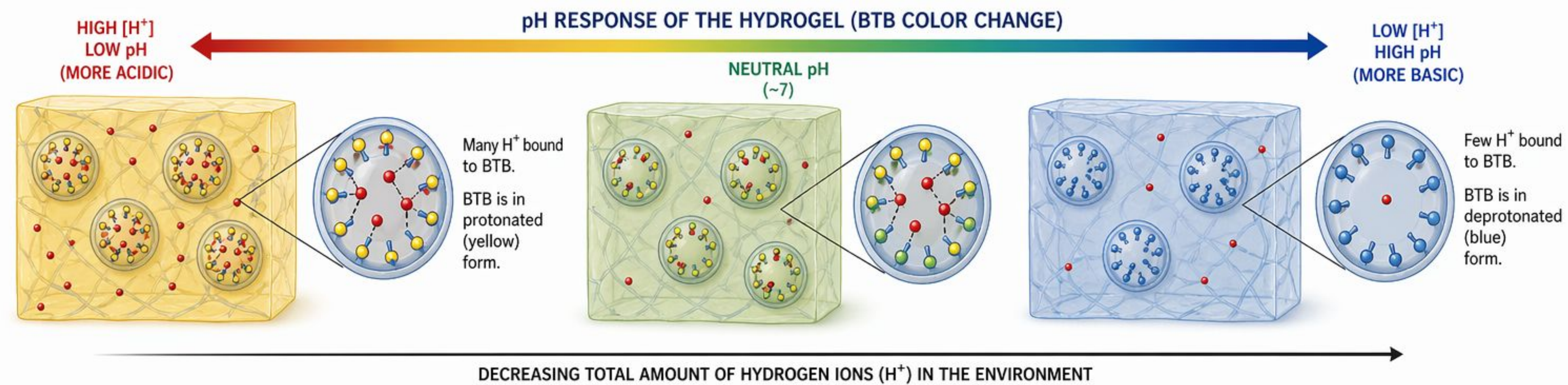
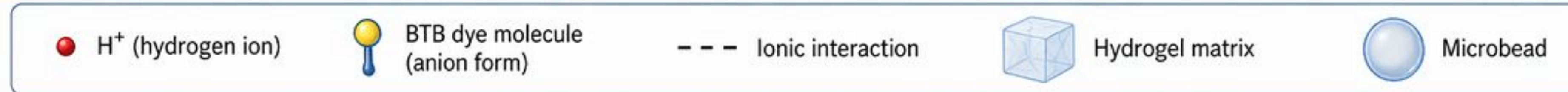
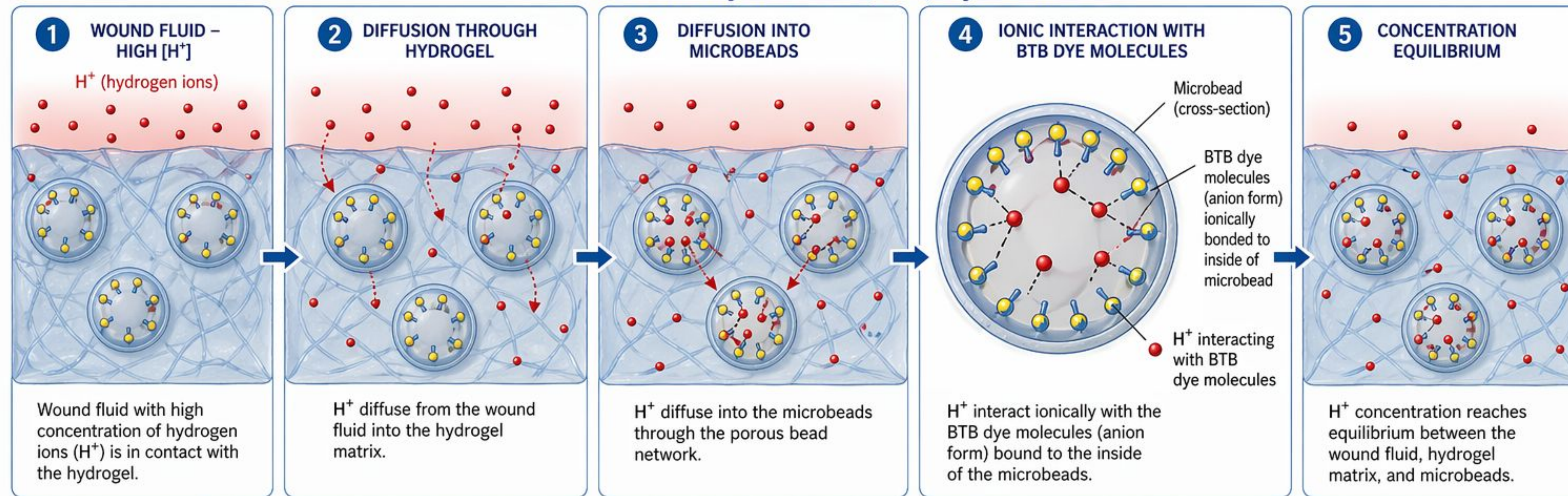
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Hydrogen Ions Diffusing Through Hydrogel and Microbeads to Reach Equilibrium with Bromothymol Blue (BTB) Dye Molecules



- Include sizes!

Questions

For technical design area, would it be better to include like a schematic of the detection mechanism to help with design and technical understanding? Or schematics of the unit product and included manual to help with understanding of consumer use? Or would we want to substitute the mechanism modeling (equations and graphs) for both of the above?