

A Novel Thermoresponsive S53P4 Bioactive Glass Extract-Poloxamer 407 Injectable Hydrogel with Potent Antibacterial Activity for Infection Management

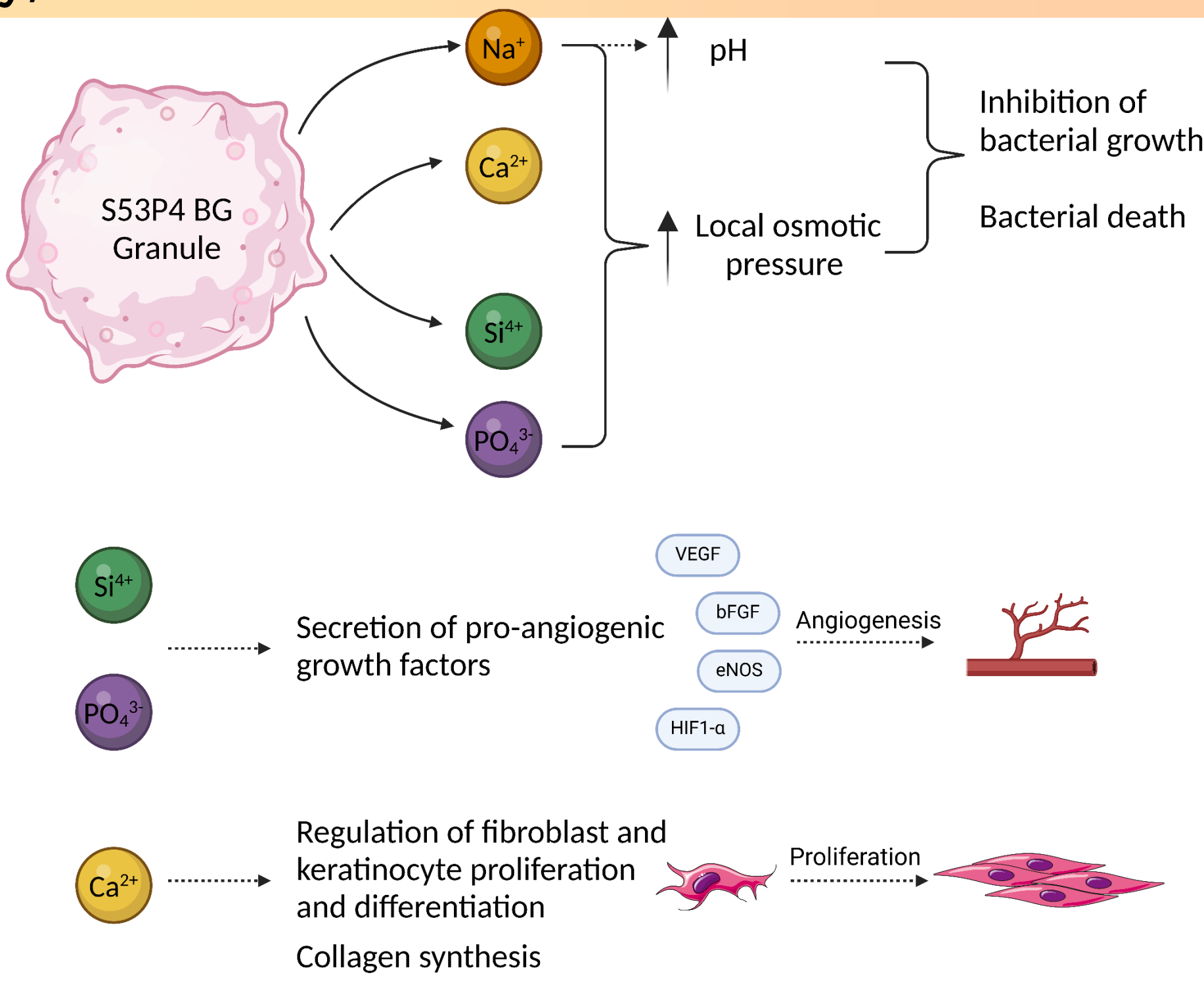
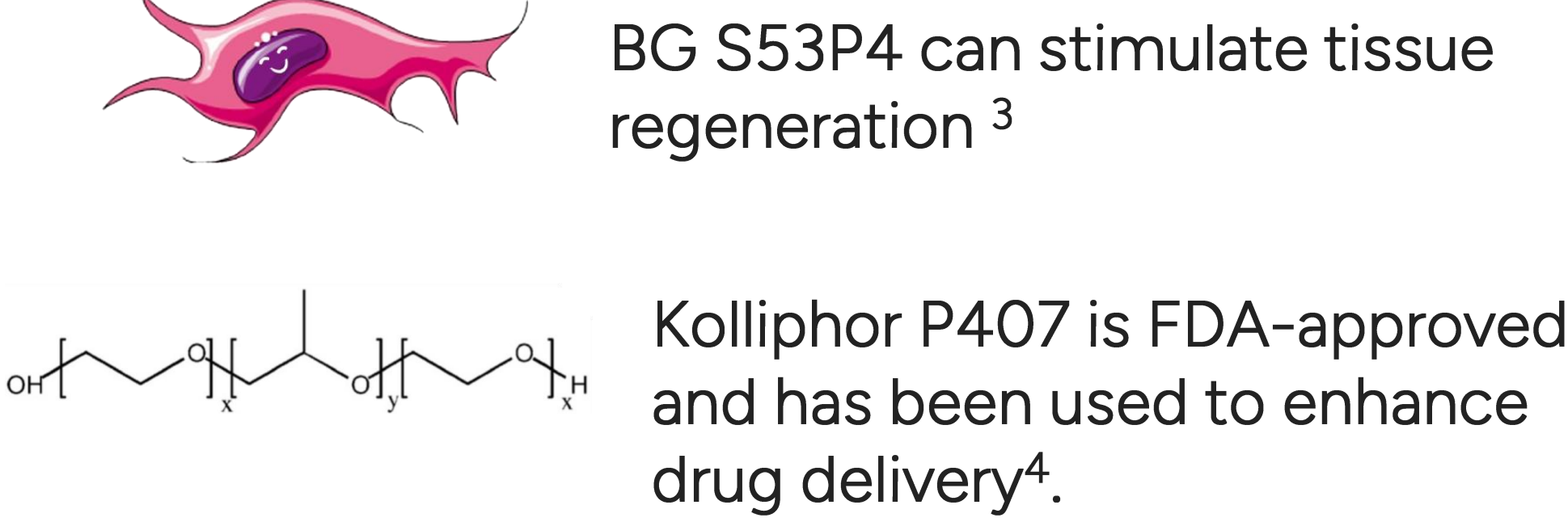
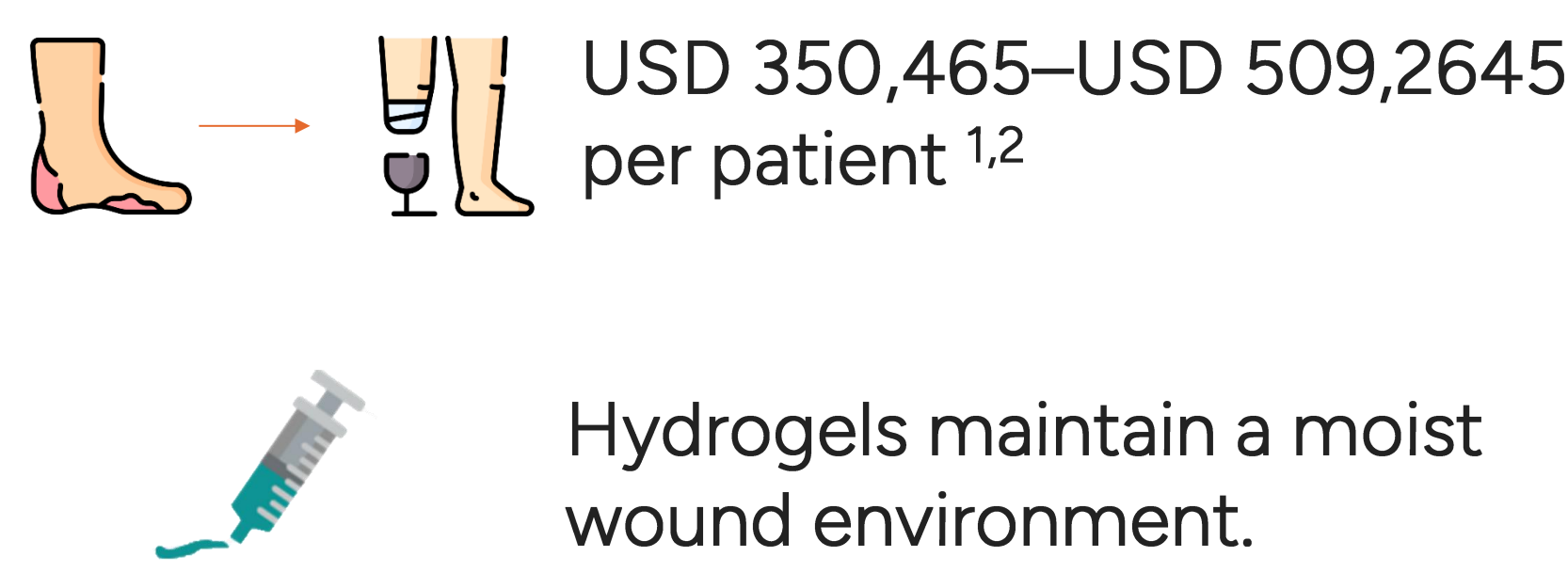
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Background

Study Aim: This research aims to incorporate bioactive glass into an injectable hydrogel system, leveraging the wound-healing properties offered by bioactive glass while simultaneously providing a moist environment created by the hydrogel. This is proposed as a solution to accelerate the healing of diabetic foot wounds of different shapes and sizes.



Methods

Hydrogel Characterization

- Gelation Temperature Determination by Rheological Measurements
- pH measurements

Biocompatibility

Assay: WST-1 (Sigma-Aldrich, 11644807001)
Based on: ISO 10993-5

$$Viability\% = \frac{OD_{450\ Sample} - OD_{620\ Sample}}{OD_{450\ Blank} - OD_{620\ Blank}} * 100$$

Cell lines:

- L929 mouse fibroblasts
- Human Umbilical Vein Endothelial Cells, HUVECs

Determination of antibacterial properties

Assay: Quantification of antibacterial properties based on Chen et al. (2021)⁵.
Inoculum concentration: 10⁵ CFU/mL

Strains:

- S. Aureus ATCC 25923
- E. Coli ATCC 25922

Results

Physical and Chemical Characterization

Figure 2. Ion concentrations present in hydrogels made with different bioactive glass extract concentrations before and after cycling them six times through their sol-gel transition temperature; a) corresponds to 0.10BG_KP407, while b) corresponds to 0.50BG_KP407.

Biocompatibility assessment by WST-1 assay following ISO 10993-5

Figure 3. Hydrogel Physical Properties. (a) Demonstrates the spreadability of the hydrogel. (b) Shows the hydrogel's adaptability to various shapes and sizes. Note: Food dye was added for visualization purposes only.

Antibacterial properties

The significant bacterial reduction (more than 2 log) achieved by all hydrogel formulations demonstrates relevant antibacterial activity against *S. aureus* ATCC 25923 and *E. coli* ATCC 25922⁶.

Table 1. Gelation Temperature of the Different Hydrogel Formulations obtained by Rheological Measurements

Sample	Gelation Temperature
Saline_KP407	18.2 °C
0.10BG_KP407	17.2 °C
0.15BG_KP407	16.7 °C
0.20BG_KP407	16.4 °C
0.50BG_KP407	15.5 °C

As the concentration of S53P4 BG increases, the gelation temperature decreases.

Dissolution rate for the gels range from 2.48 [mg min⁻¹ cm⁻²] for 0.50BG_KP407 to 4.5 [mg min⁻¹ cm⁻²] for 0.10BG_KP407

Conclusions

- The hydrogels' thermoreversible gelation property allows them to adapt to wounds of all shapes, depths, and sizes.
- The pH difference from the just synthesized hydrogel to the 10th cycle does not affect the ion concentrations present.
- The synthesized hydrogels meet the biocompatibility standard of ISO993-5 (above 70% viability) for both L929 mouse fibroblasts and HUVECs.
- The hydrogels exhibit a clinically relevant antibacterial activity (over 2 log reduction) for gram-positive (*S. aureus* ATCC 25923) and gram-negative (*E. coli* 25922) bacteria.

Acknowledgements

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