

Microenvironment-Responsive Polyethylene Glycol-Based Hydrogel Scaffolds for Vascularized Tissue Engineering

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INTRODUCTION & AIM

- Poor vascularization remains a major challenge in hydrogel-based tissue engineering.
- Conventional PEG hydrogels provide good biocompatibility but limited responsiveness to the tissue microenvironment.
- Native tissues dynamically respond to enzymatic activity and oxygen availability during regeneration.
- This work explores the design of a dual-responsive PEG hydrogel system incorporating:
 - MMP-sensitive peptide crosslinkers
 - Oxygen-responsive components
- Aim:
 - Enhance scaffold adaptability
 - Improve endothelial infiltration
 - Support vascularization and tissue regeneration

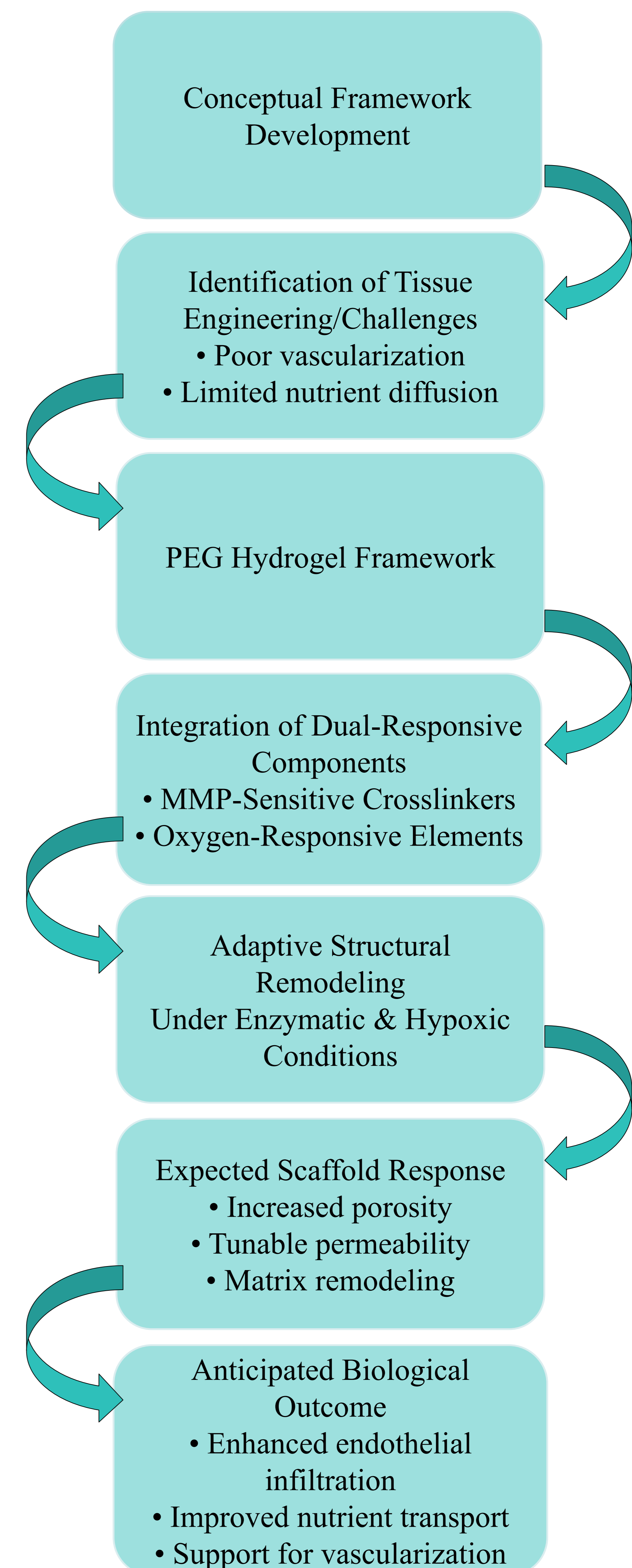
RESULTS & DISCUSSION

- Previous studies have demonstrated that adaptive PEG hydrogels can respond dynamically to microenvironmental changes.
- MMP-sensitive crosslinkers support controlled scaffold degradation and matrix remodeling.
- Oxygen-responsive behavior promotes localized structural loosening under hypoxic conditions.
- Reported pore sizes ranging from approximately 30–110 μm may enhance nutrient diffusion and cellular infiltration.
- Increased permeability has been associated with improved endothelial migration and vascular-like network formation.
- Compared with conventional PEG hydrogels, adaptive systems have shown enhanced endothelial infiltration and improved vascularization potential.
- These findings highlight the potential of dual-responsive hydrogels for advanced tissue engineering applications.

CONCLUSIONS

- Dual-responsive PEG hydrogels offer a promising strategy for adaptive tissue engineering scaffolds.
- Environmentally responsive behavior may improve permeability and endothelial infiltration.
- Dynamic scaffold remodeling has the potential to overcome limitations associated with static hydrogel systems.
- Adaptive PEG hydrogels may provide improved support for vascularization and tissue regeneration.

METHODS



FUTURE WORK/ REFERENCES/ACKNOWLEDGMENT

- Future experimental studies are required to validate the proposed hydrogel framework under physiological conditions.
- In vitro evaluation of endothelial cell infiltration and vascularization potential will be investigated.
- Additional studies will examine scaffold permeability, pore size variation, and structural remodeling under hypoxic environments.
- Optimization of the oxygen-responsive and enzymatic-responsive components will be explored.
- Future work may also investigate in vivo tissue regeneration performance and therapeutic delivery applications.