



On-demand Activation of Flexible Magnetolectric Membrane Enhances Bone Defect Repair



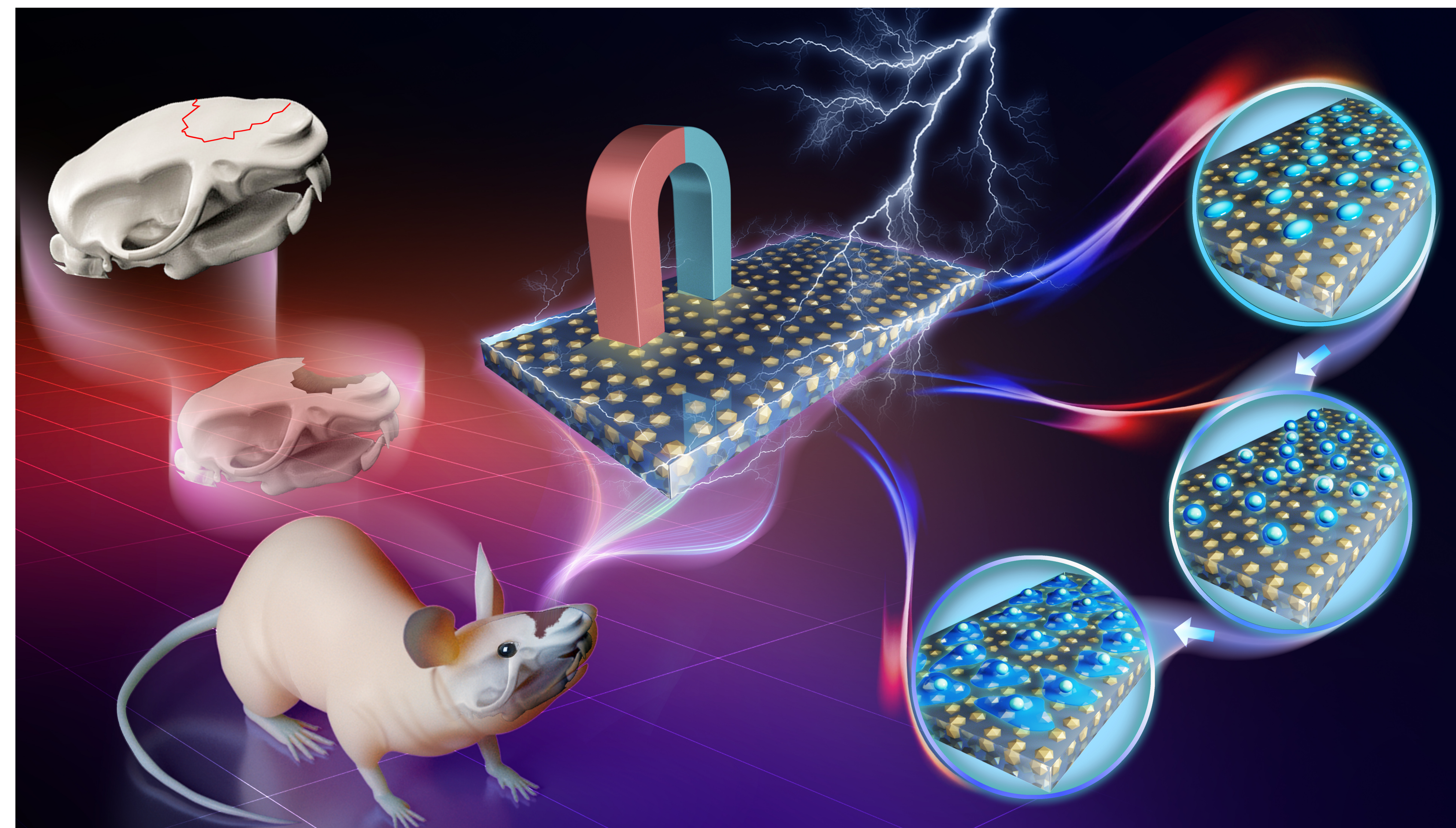
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BACKGROUND

1. A major strategy in tissue engineering is to mimic the biophysical properties of the extracellular environment to modulate cell function via cell–material interactions.
2. Mimicking the endogenous physical microenvironment is a promising strategy for biomaterial-mediated tissue regeneration.
3. Precise control of physical cues such as electric/magnetic fields within extracellular environments to facilitate tissue regeneration remains a formidable challenge.



INTRODUCTION

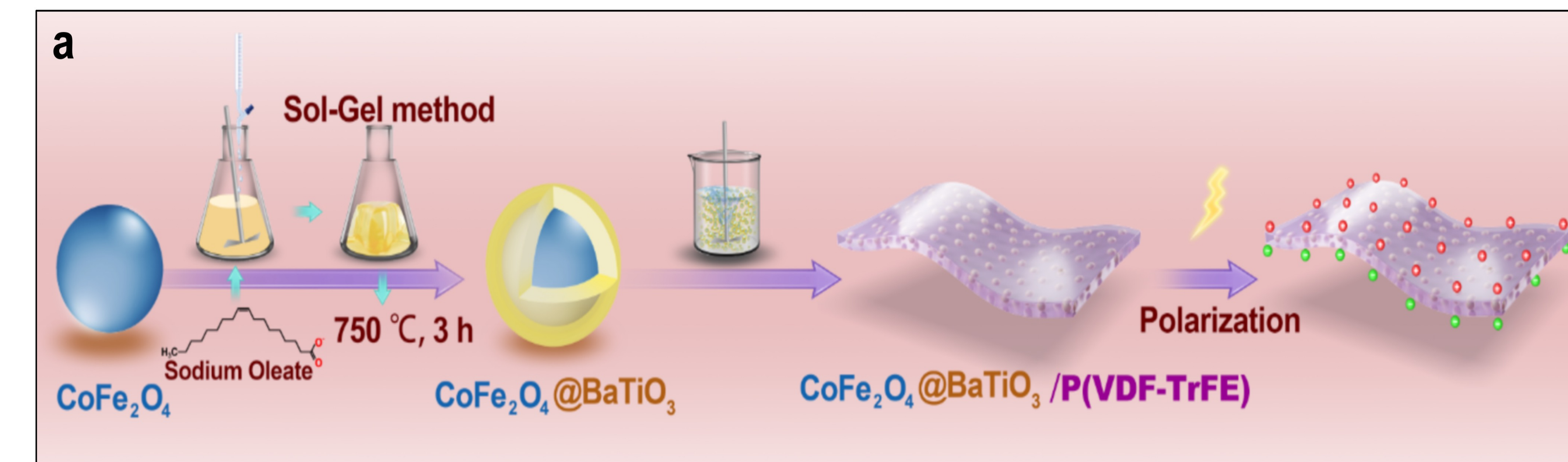
1. For bone defect repair under co-morbidity conditions, the use of biomaterials that can be non-invasively regulated is highly desirable to promote osteogenesis.
2. Achieving efficient osteogenesis with stimuli-responsive materials remains a significant challenge in clinical applications.
3. In this study, we developed polarized $\text{CoFe}_2\text{O}_4@\text{BaTiO}_3/\text{P}(\text{VDF-TrFE})$ core-shell composite membranes (CSCM) with high magnetoelectric conversion efficiency to facilitate bone regeneration on demand.

METHODS & RESULTS

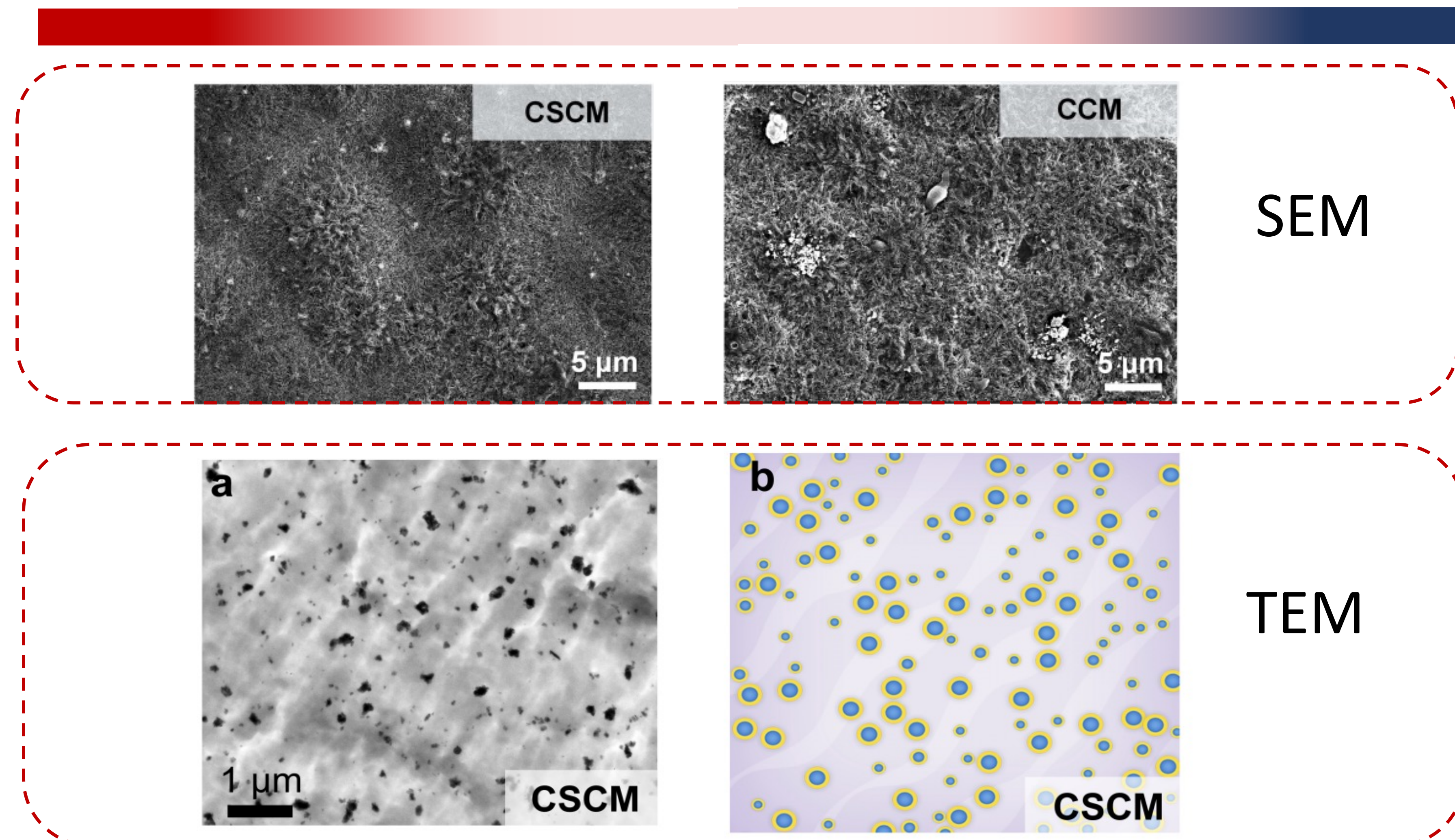
Membrane mediated bone regeneration in inflammation model

BMSCs osteogenesis

Fabrication of CSCM magnetoelectric membranes

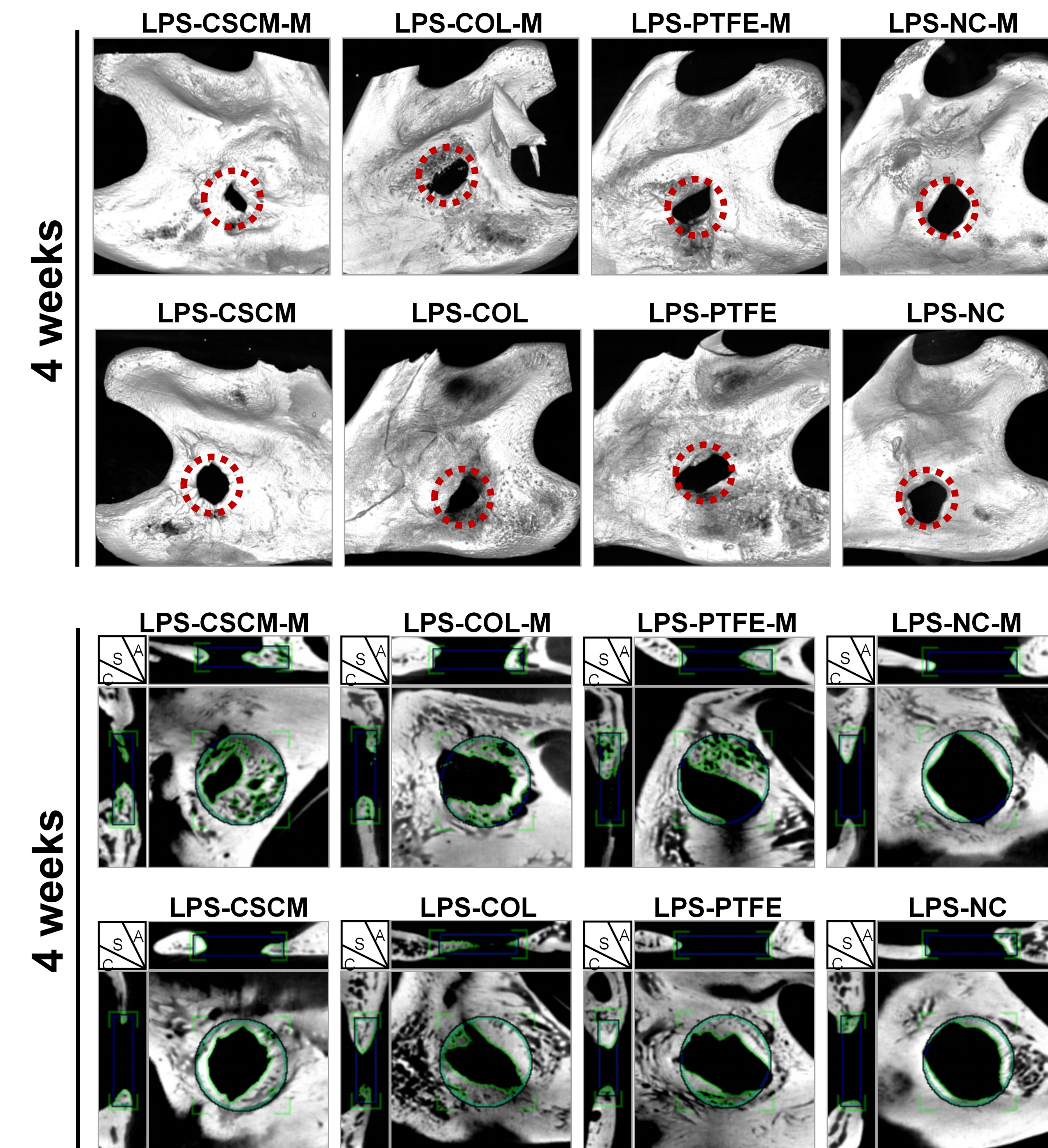
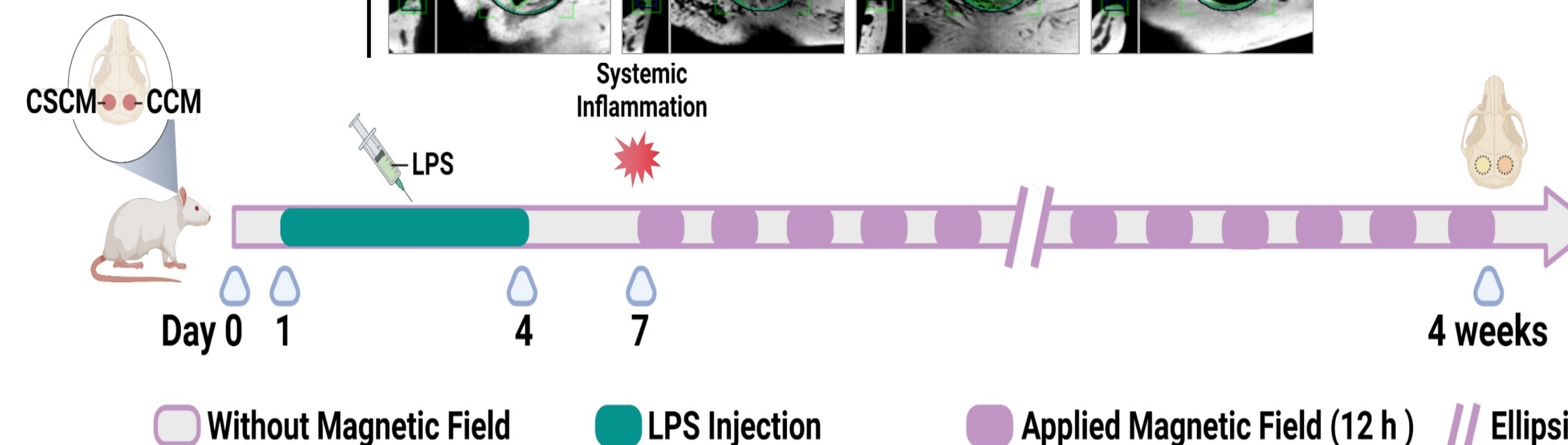
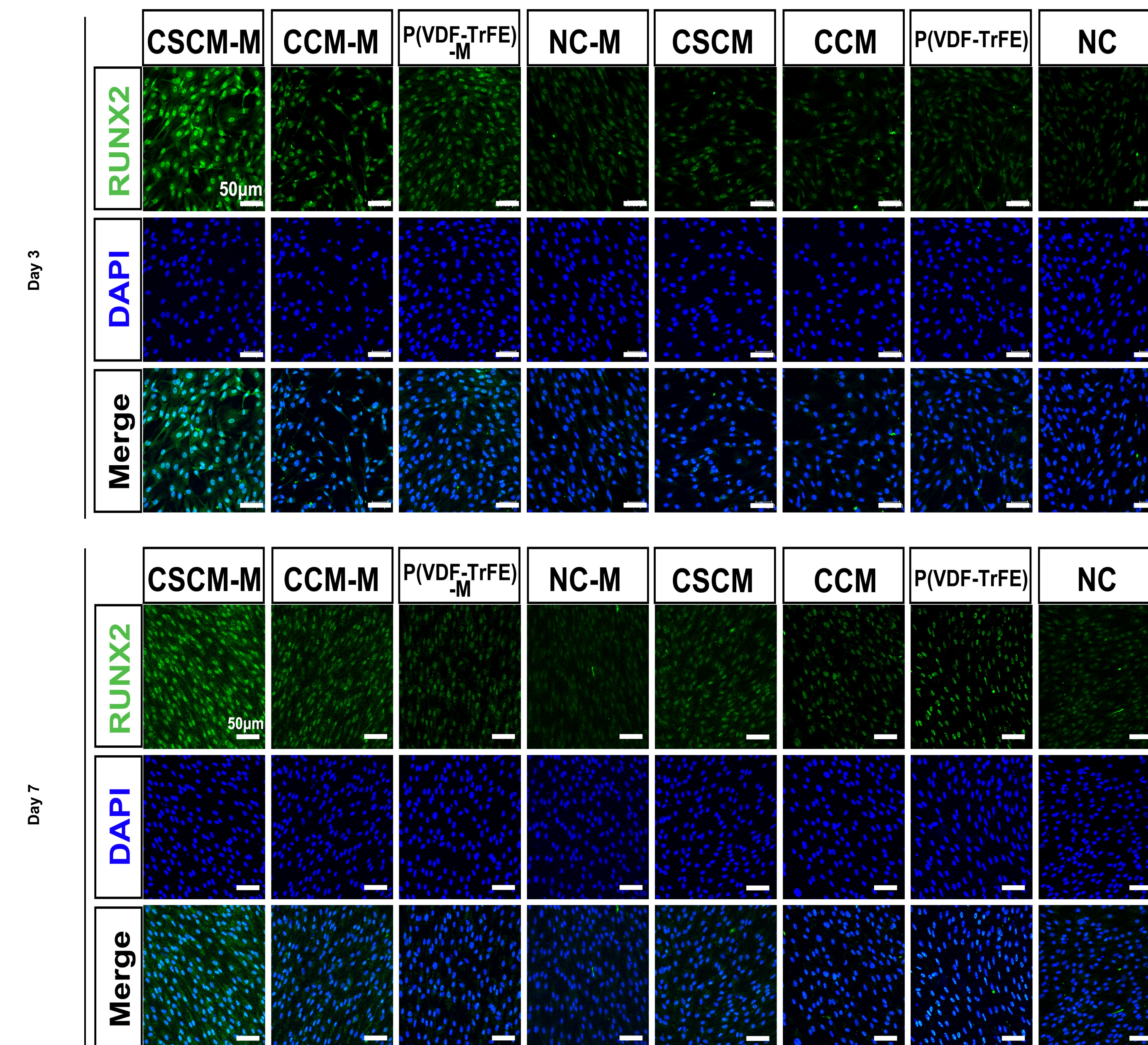


SEM&TEM of CSCM



CFO nanoparticle incorporated composite membranes (CCM)

Core-shell particle-incorporated composite membranes (CSCM)



Immunostaining images showed the upregulated expression of RUNX2 in the CSCM-M group after 3 and 7 days of cell culture (Scale bars: 50 μm).

DISCUSSION & SUMMARY

1. We fabricated a magnetic field-responsive core-shell structured CFO@BTO/P(VDF-TrFE) membrane (CSCM). The membrane provides a remote stimuli-responsive electrical microenvironment that can reactivate bone regeneration even under inflammatory conditions.
2. Consistent with the prediction of MD simulation, the magnetoelectric microenvironment provided by CSCM can modulate cellular behavior.
3. Magnetic field modulation is a safe and convenient method that can be easily applied with high tissue penetration depth in the clinic. With CSCM application, a smart in situ repowering strategy based on magnetic field loading can reactivate bone regeneration under co-morbidity conditions. Using stimuli-responsive magnetoelectric coupling membranes that can be repowered by an external magnetic field, exhibits promising development potential for clinical applications.

