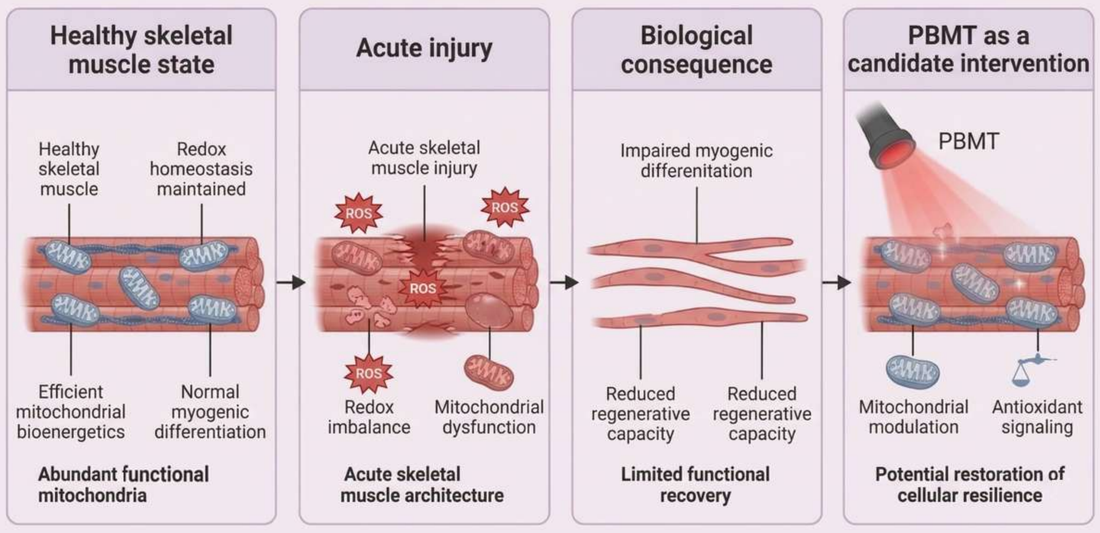
Photobiomodulation Enhances Mitochondrial Recovery and Myogenic Differentiation After Skeletal Muscle Injury

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Background

Acute skeletal muscle injury induces oxidative stress and mitochondrial dysfunction, impairing myogenesis and regeneration. PBMT targets these pathways, but whether preconditioning or postinjury treatment is more effective remains unknown.



Aims

To determine whether PBMT timing (pre-conditioning vs post-injury intervention) differentially modulates oxidative stress regulation, mitochondrial recovery, and myogenic differentiation following acute skeletal muscle injury.

Methodology

Acute injury induced by 12% $BaCl_2$ (6h exposure)
Experimental Groups

- Injury-only
- Control
- PBMT pre-conditioning
- PBMT post-injury treatm

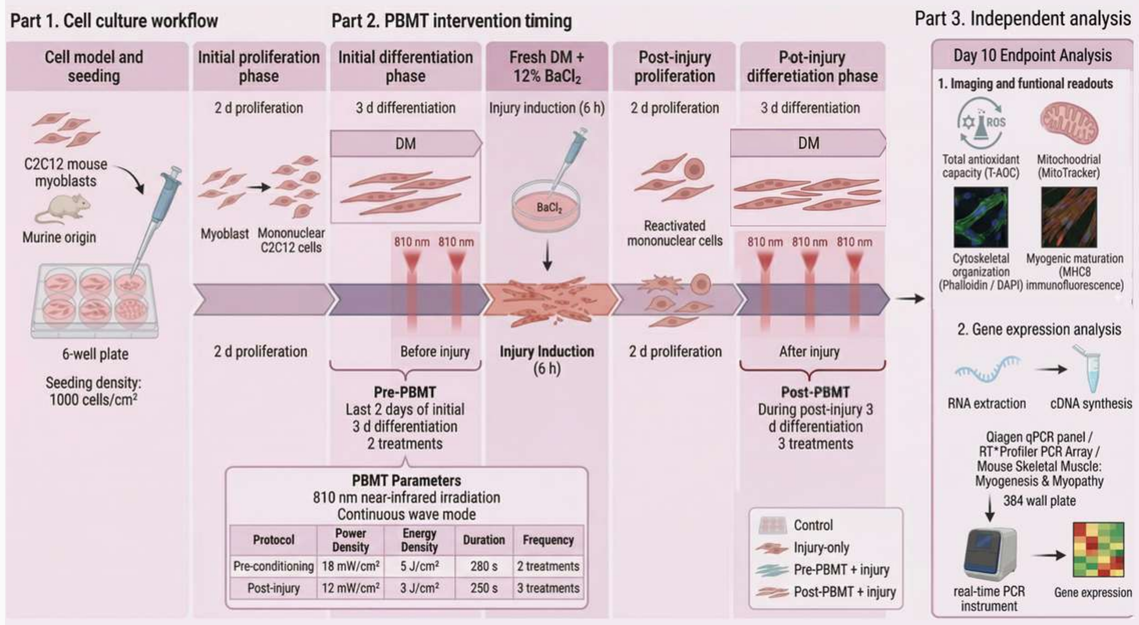


Figure 1. Schematic overview of the 2D skeletal muscle injury model and PBMT study design.

Result –Antioxidant test

Total antioxidant capacity was reduced after injury in both stages, but PBMT improved the antioxidant response.

Table 1. T-AOC values at the end of GM and DM stages

Group	GM	DM
Injury only	0.48	0.41
Pre-PBMT	0.55	0.52
Post-PBMT	—	0.56

Together, these data show that PBMT enhanced antioxidant capacity in both stages, with the strongest effect observed in the DM stage when PBMT was applied after injury.

Result- Mitochondrial Recovery, Cytoskeletal Organisation, and Myogenic Differentiation

PBMT promotes muscle regeneration by:

- **Enhancing cytoskeletal reorganization** and myotube structure
- **Improving myogenic maturation**, with post-injury PBMT yielding the highest fusion index (**74 ± 5%**)

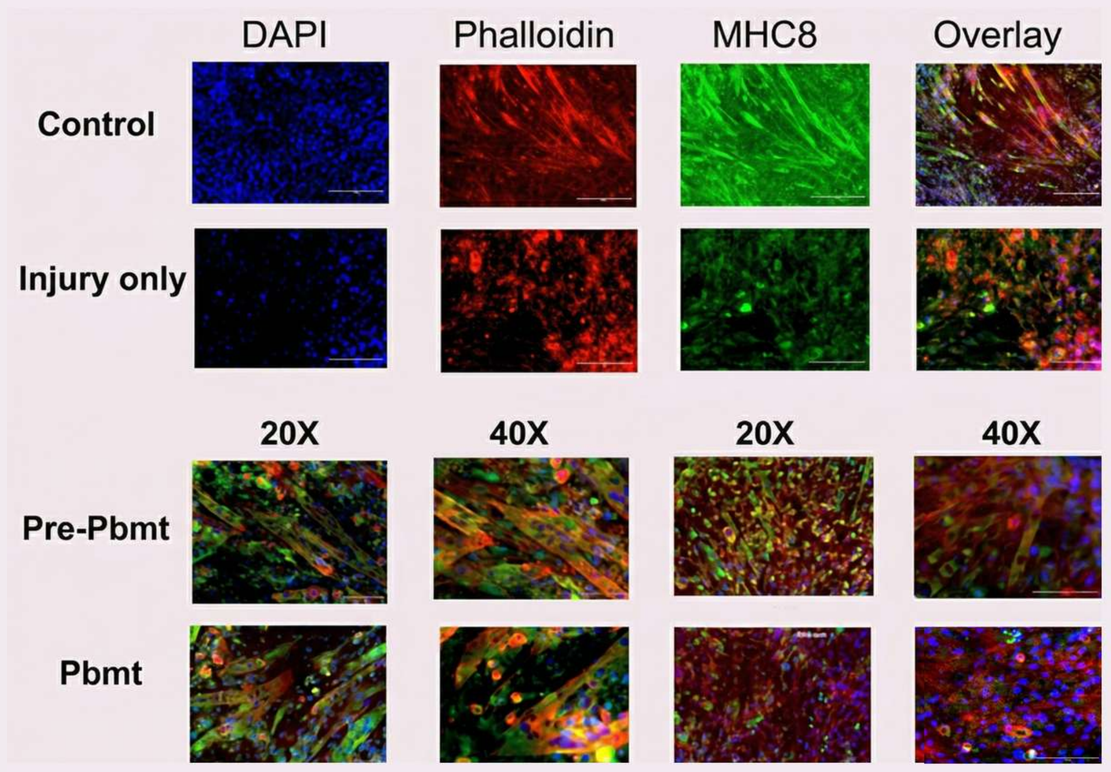


Figure 2. Immunofluorescence of injured C2C12 myotubes (DAPI/Phalloidin/MHC8). PBMT restores actin alignment and promotes myotube maturation, with maximal fusion observed in post-injury treatment. 20× and 40× magnification

Myogenic endpoint analysis

Fusion efficiency dropped sharply after injury. PBMT partially improved fusion, while the strongest recovery was observed in the After DM (post) group. This suggests that PBMT enhances myogenic fusion in a timing-dependent manner, with post-injury intervention during differentiation being the most effective.

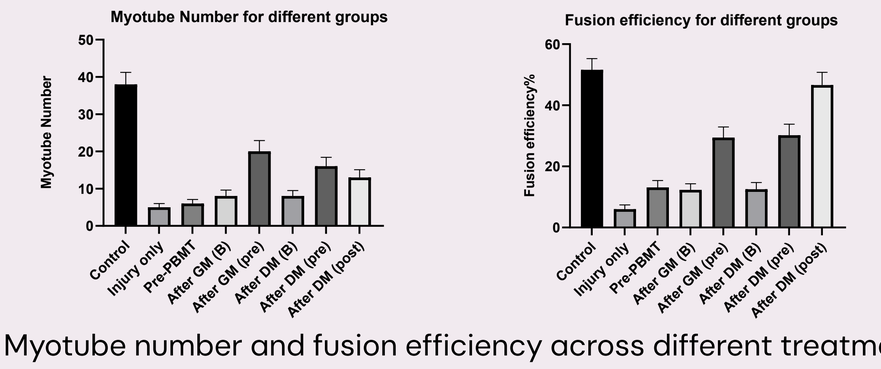


Figure 3. Myotube number and fusion efficiency across different treatment groups.

RT² Profiler™ PCR Array Mouse Skeletal Muscle: Myogenesis & Myopathy

- PBMT increased **Ppargc1a, Dag1, Mb, Sgca, Igfbp3, Igfbp5, and Myod1,** supporting improved oxidative metabolism, structural stability, and myogenic signalling.
- **Il6, Mstn, and Nos2** showed strong inflammatory
- Data support improved oxidative metabolism, membrane structural integrity, and muscle functional adaptation

Conclusion

Timing-optimized 810 nm PBMT modulates redox stability and mitochondrial resilience to enhance myogenic regeneration, supporting its application in engineered muscle systems.

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