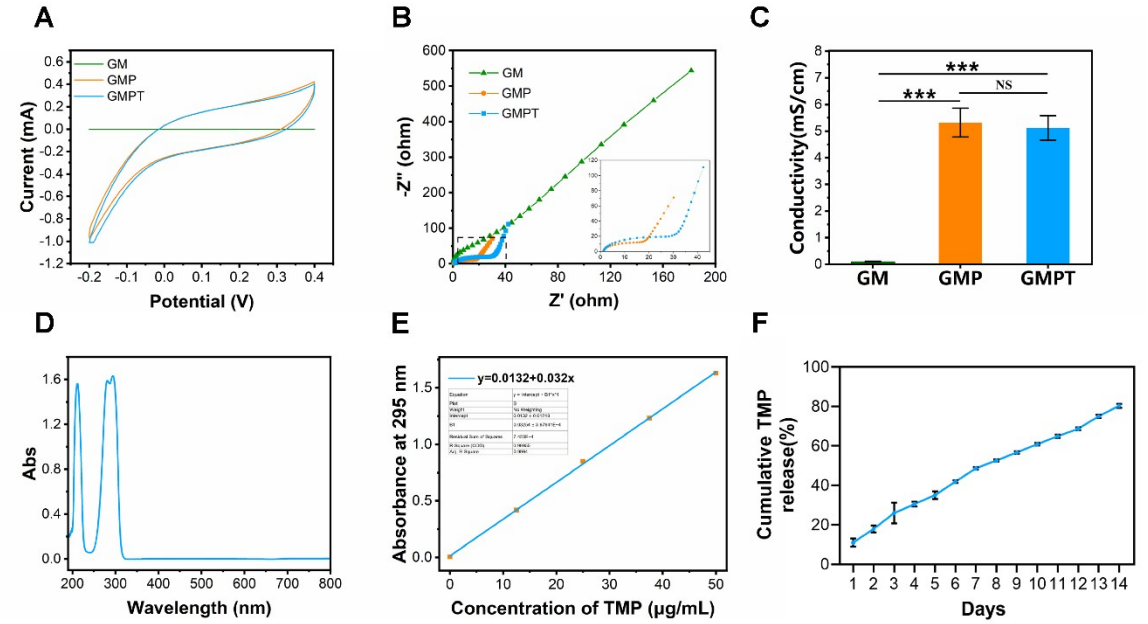

Fig. S1 Physical properties of hydrogels. Electrochemical Characterization of GM, GMP, and GMPT Hydrogels, including CV (A), EIS (B), and conductivity (C) is shown here. The properties of GMPT hydrogel regarding drug release were evaluated *in vitro*. (D) The maximum absorption peak for TMP was observed at a wavelength of 295 nm. (E) TMP standard concentration curve is presented here. (F) The cumulative release of TMP from GMPT hydrogels over 14 days was monitored. Groups were analyzed with a one-way ANOVA and Bonferroni multiple comparison test (***$P < 0.001$).

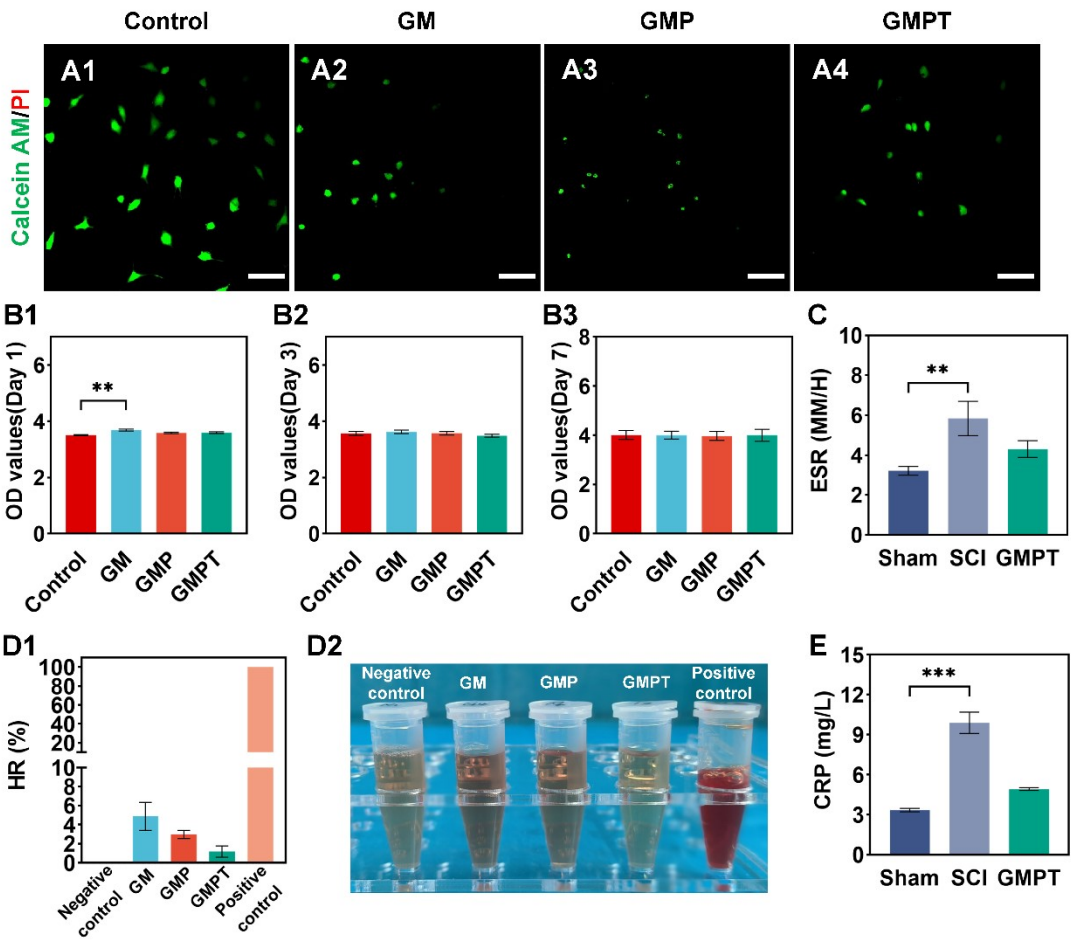

Fig. S2 Biocompatibility of the hydrogels. (A1-A4) Neural stem cells were co-cultured *in vitro* with various hydrogels and subsequently subjected to live-dead staining to evaluate cellular viability. Scale bars: 50 μm. (B1-B3) Following 1, 3, and 7 days of co-culturing neural stem cells with various hydrogels *in vitro*, cell proliferation was assessed using the CCK-8 assay. After implantation of GMPT hydrogels into the spinal cord gap for 28 days, alterations in the expression levels of CRP (C) and ESR (E) in the circulating blood were analyzed to monitor the systemic inflammatory response. (D) The hemocompatibility of various hydrogels was analyzed. Photographs of serum extracted from arterial blood co-cultured with GM, GMP, and GMPT hydrogels in conjunction with the corresponding hemolysis rate (D1 and D2), n = 6. In the serum photographs, the color of the sample from the GMPT group resembled the pale yellow color of the sample from the standard control group. In contrast, the samples from the positive control group exhibited a vivid red color, indicating hemolysis. Groups were analyzed with a one-way ANOVA and Bonferroni multiple comparison test (**$P < 0.01$, ***$P < 0.001$).

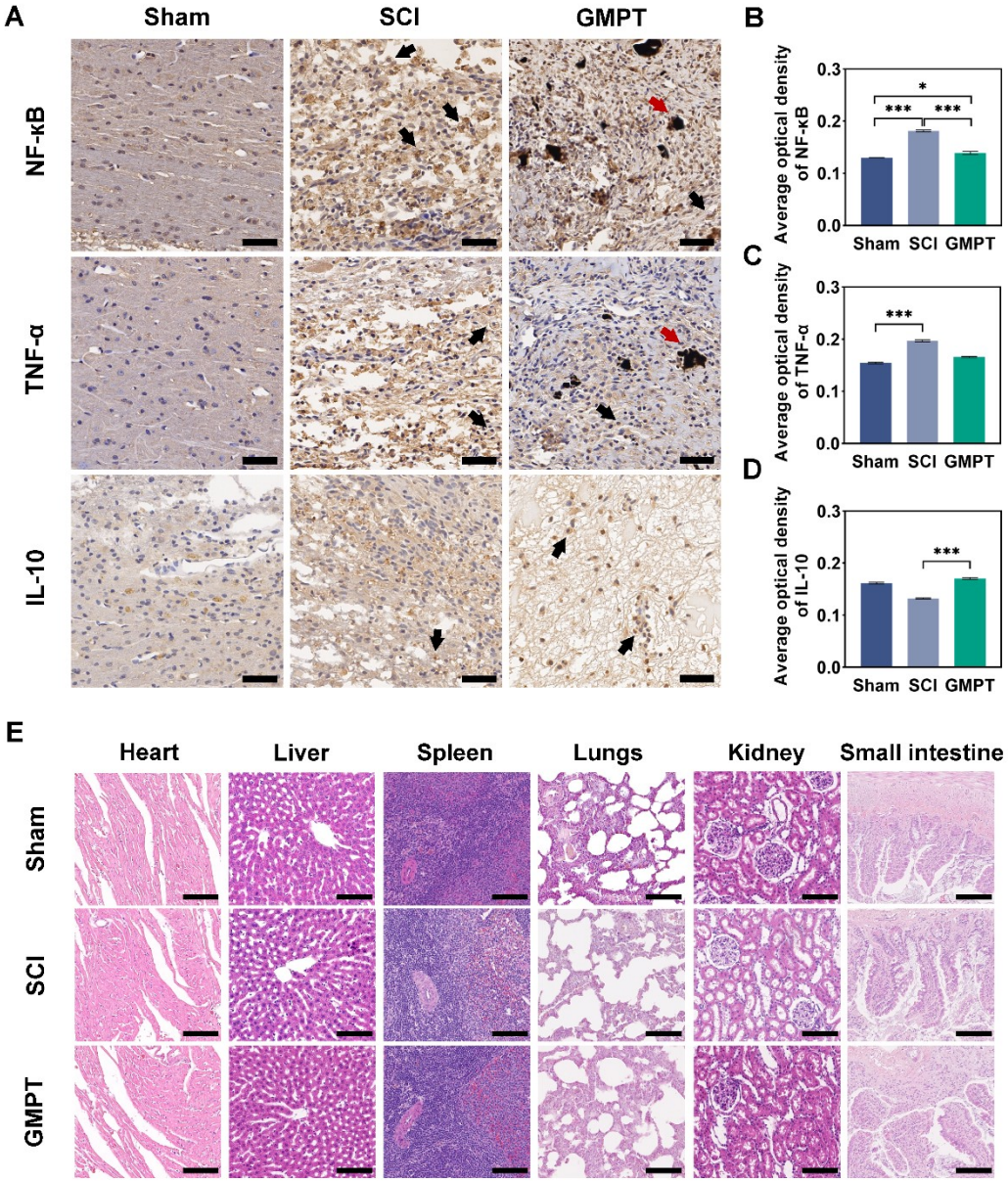

Fig. S3 *In vivo* biocompatibility of GMPT hydrogels. (A) IHC was employed to observe the spatial distribution of three inflammatory proteins (NF-κB, TNF-α, and IL-10) in the lesion area 28 days post hydrogel implantation. (B-D) Semi-quantitative analyses of these expressions are presented here. The black arrows indicate different inflammatory protein expressions. The red arrows indicate conductive particles. Scale bars: 60 μm. n = 6. (E) Hematoxylin and eosin (H&E) staining delineated the histological morphology of the heart, liver, spleen, lungs, kidneys, and small intestine in different groups. Scale bars: 100 μm. Groups were analyzed with a one-way ANOVA and Bonferroni multiple comparison test (***$P < 0.001$).

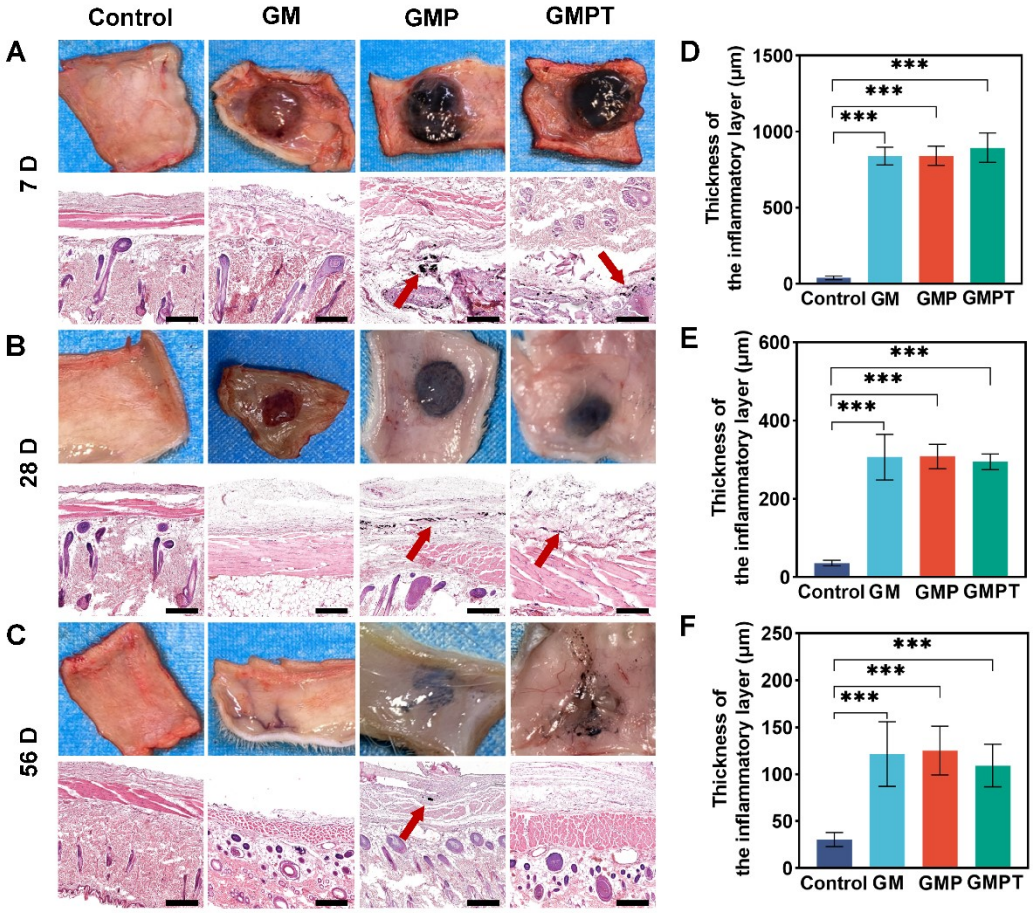

Fig. S4 *In vivo* degradation properties of various implanted hydrogels. (A-C) Subcutaneous implantation of GM, GMP, and GMPT hydrogels is showcased here, with the degradation status at various time points in conjunction with HE histopathological staining results. The red arrows denote progressively degrading conductive particles. At post-implantation intervals of 7 days (D), 14 days (E), and 56 days (F), the thickness of the inflammatory layer in the skin tissue was quantified. Scale bars: 400 μm. n = 6. Groups were analyzed with a one-way ANOVA and Bonferroni multiple comparison test (***P < 0.001).

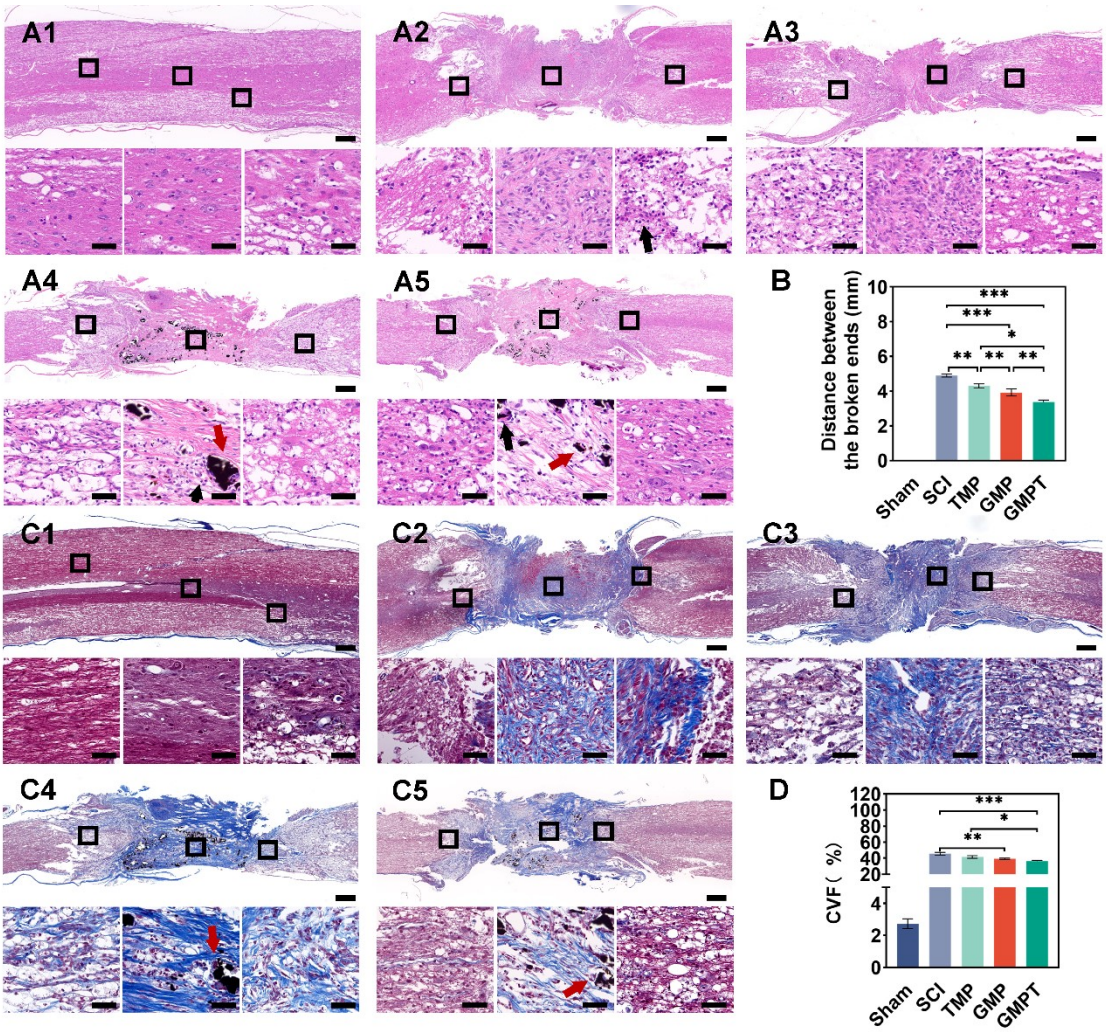

Fig. S5 GMPT hydrogel mitigated secondary pathological damage following SCI. (A1-A5) HE staining results of spinal cord tissues at 28 days post-injury for sham, SCI, TMP, GMP, and GMPT groups, respectively are presented here. Black arrows indicate inflammatory cells, while red arrows indicate conductive particles. (B) The distance between the broken ends on either side of the spinal cord tissue for each group is presented here. Masson staining was used to observe alterations of collagen fibers in the sham (C1), SCI (C2), TMP (C3), GMP (C4), and GMPT groups (C5) at 28 days after injury. Scale bars: 0.6 mm and 40 μm. (D) Collagen volume fractions (CVFs) of spinal cord tissues in the respective groups are presented here. n = 6. Groups were analyzed with a one-way ANOVA and Bonferroni multiple comparison test (*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$).

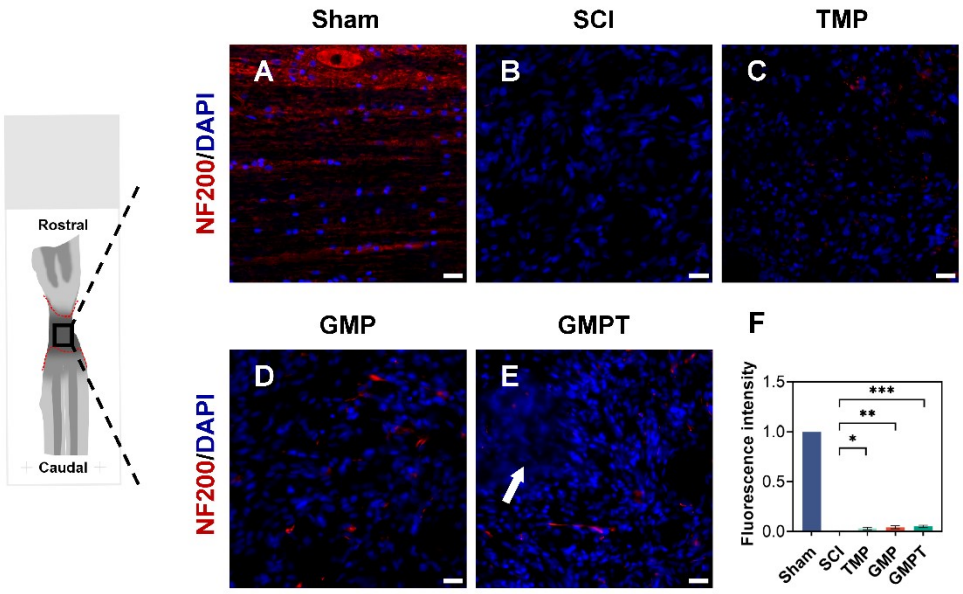

Fig. S6 Implantation of GMPT hydrogel facilitated neural regeneration *in vivo*. (A-E) Alteration of neurofilaments (NF) in the injury site is shown. NF intensity was quantified from the same area 28 days after injury in different groups (F). Red arrows indicate conductive particles. The fluorescence intensity of NF was normalized relative to the sham group for quantification. Red immunofluorescent staining represents the NF-axonal marker. Scale bars: 20 μm. n = 3. Groups were analyzed with a one-way ANOVA and Bonferroni multiple comparison test (*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$).