

Figure S1. (A) GMHI Gut microbiome health index between the two groups (n=9). (B) Microbial dysbiosis index between the two groups (n=9). GMHI, gut microbiome health index; OVX, ovariectomy.

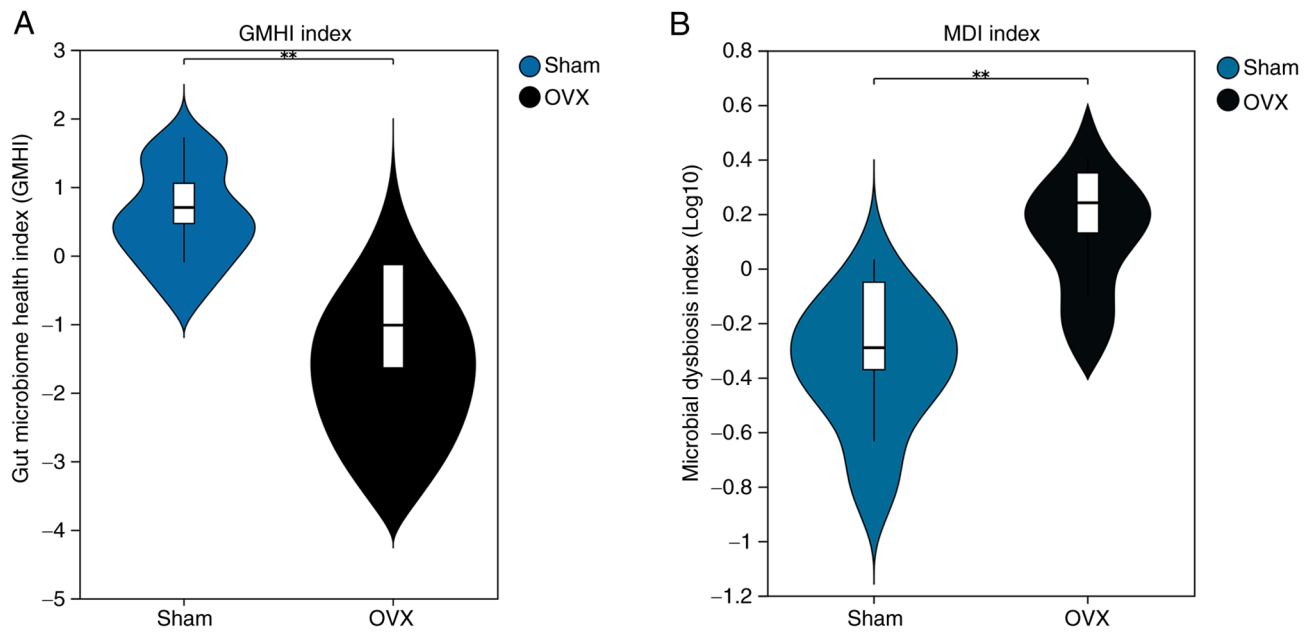


Figure S2. IPA exerts no direct effect on osteogenic differentiation of BMSCs. (A) ARS staining of mBMSCs treated with different concentrations of IPA after 25 days of osteogenic differentiation. Scale bar, 25 μm . (B) Quantification of ARS staining. (C) ALP staining of mBMSCs treated with different concentrations of IPA after 8 days of osteogenic differentiation. Scale bar, 25 μm . (D) Quantification of ALP staining. (E) Expression of osteogenesis-related proteins assessed by western blotting. (F) Quantification of western blot results. All experiments were repeated at least three times. Data are presented as the mean \pm SD. IPA, indole-3-propionic acid; BMSCs, bone marrow stromal cells; mBMSCs, mouse BMSCs; ARS, alizarin Red S; ALP, alkaline phosphatase; NS, not significant.

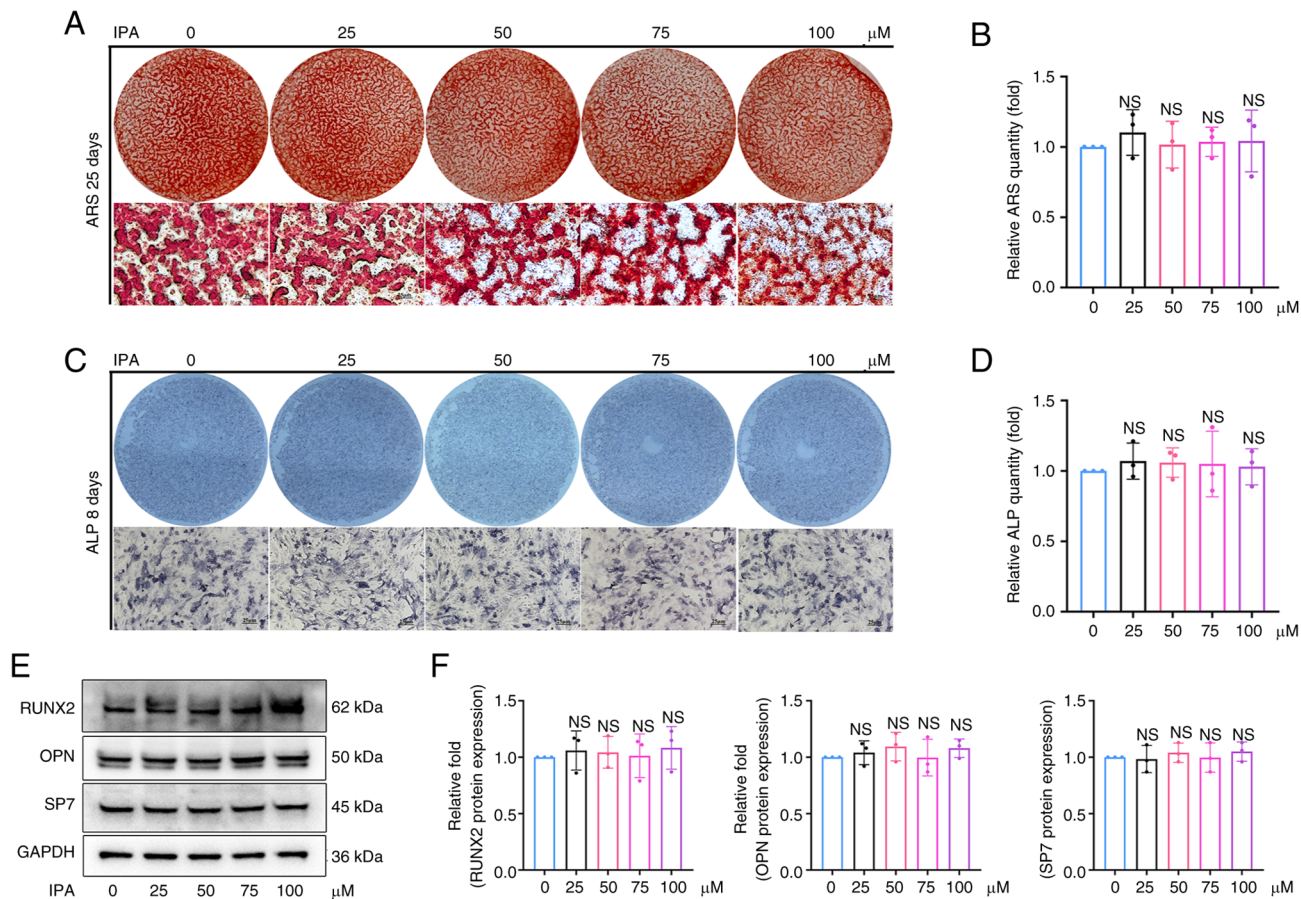


Figure S3. (A) Expression of osteogenesis-related genes in mBMSCs after 5 days of osteogenic differentiation, assessed by RT-qPCR. (B) Expression of adipogenesis-related genes in mBMSCs after 5 days of adipogenic differentiation, assessed by RT-qPCR. * $P < 0.05$ and ** $P < 0.01$ compared with the control group. mBMSCs, mouse bone marrow stromal cells; RT-qPCR, reverse transcription-quantitative PCR; IPA, indole-3-propionic acid; COL1A1, collagen, type I, alpha 1; RUNX2, Runt-related transcription factor 2; SREBP, sterol regulatory element-binding protein.

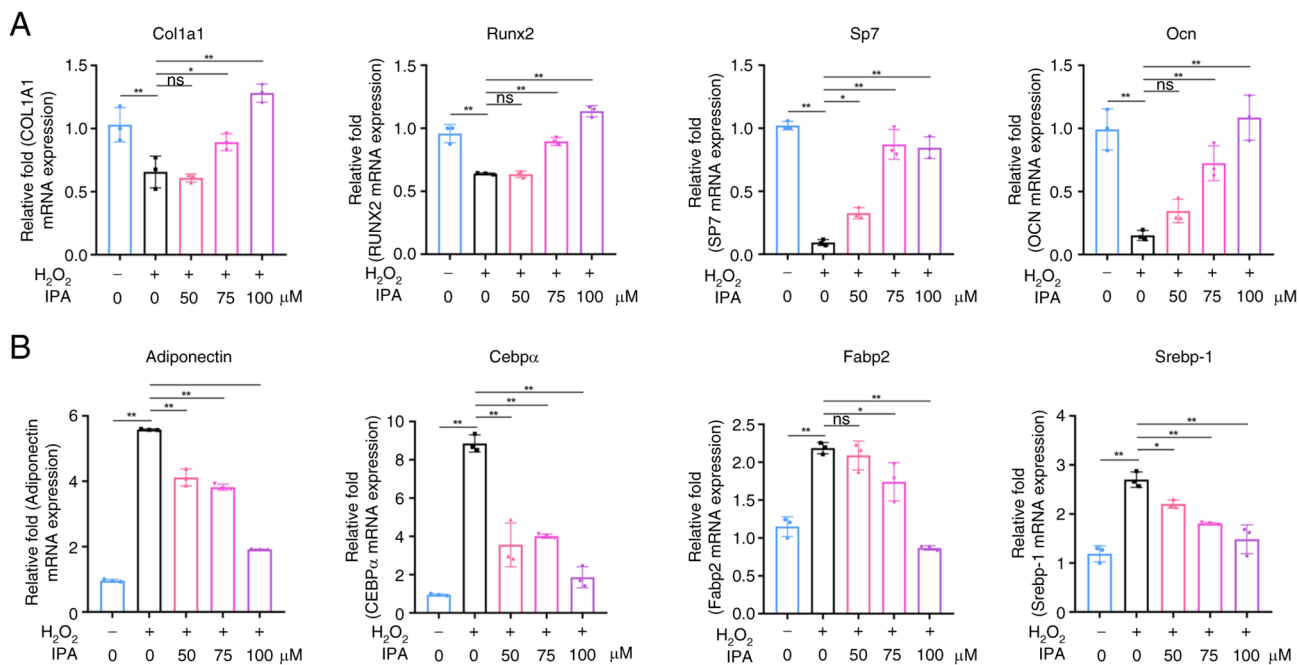


Figure S4. (A) Quantification of *COL1A1* fluorescence intensity. (B) Quantification of *RUNX2* fluorescence intensity. *P<0.05 and **P<0.01 compared with the control group. COL1A1, collagen, type I, alpha 1; RUNX2, Runt-related transcription factor 2; IPA, indole-3-propionic acid.

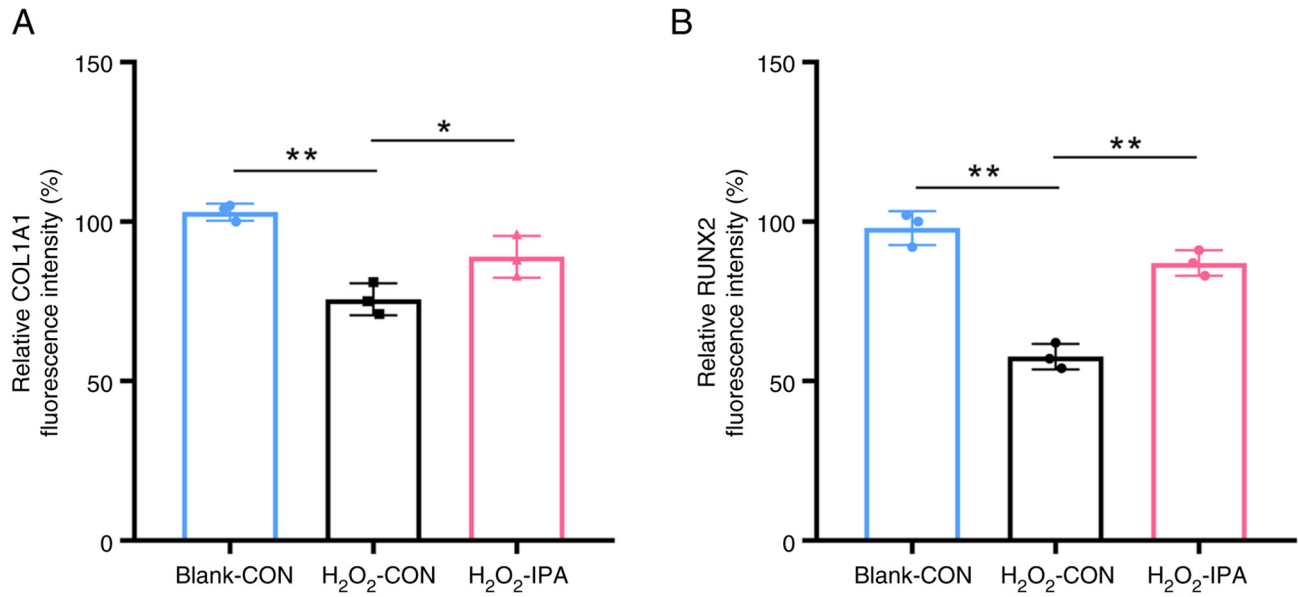


Figure S5. (A) Body weight changes throughout the experimental period in different groups. (B) Uterine weight in different groups. **P<0.01 compared with the Sham group. OVX, ovariectomy.

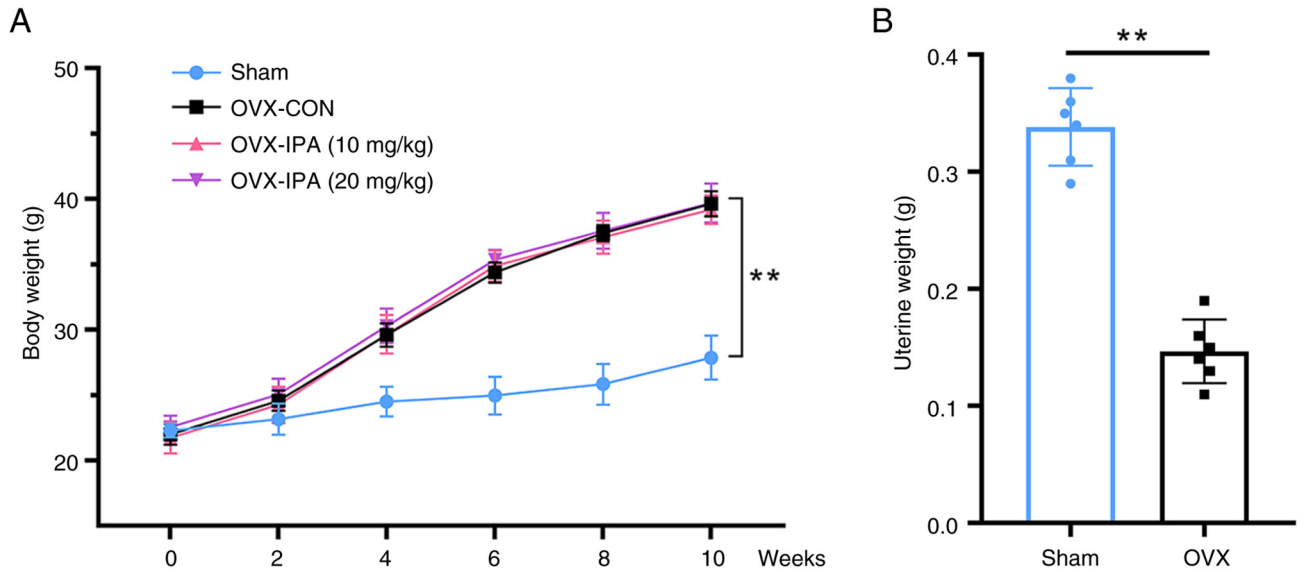


Figure S6. (A) Heatmap of Differentially expressed genes following IPA treatment under H₂O₂ intervention between the two groups. (B) GO annotation analysis showing biological process and molecular function enrichment following IPA treatment. IPA, indole-3-propionic acid; GO, Gene Ontology; BP, biological process; MF, molecular function.

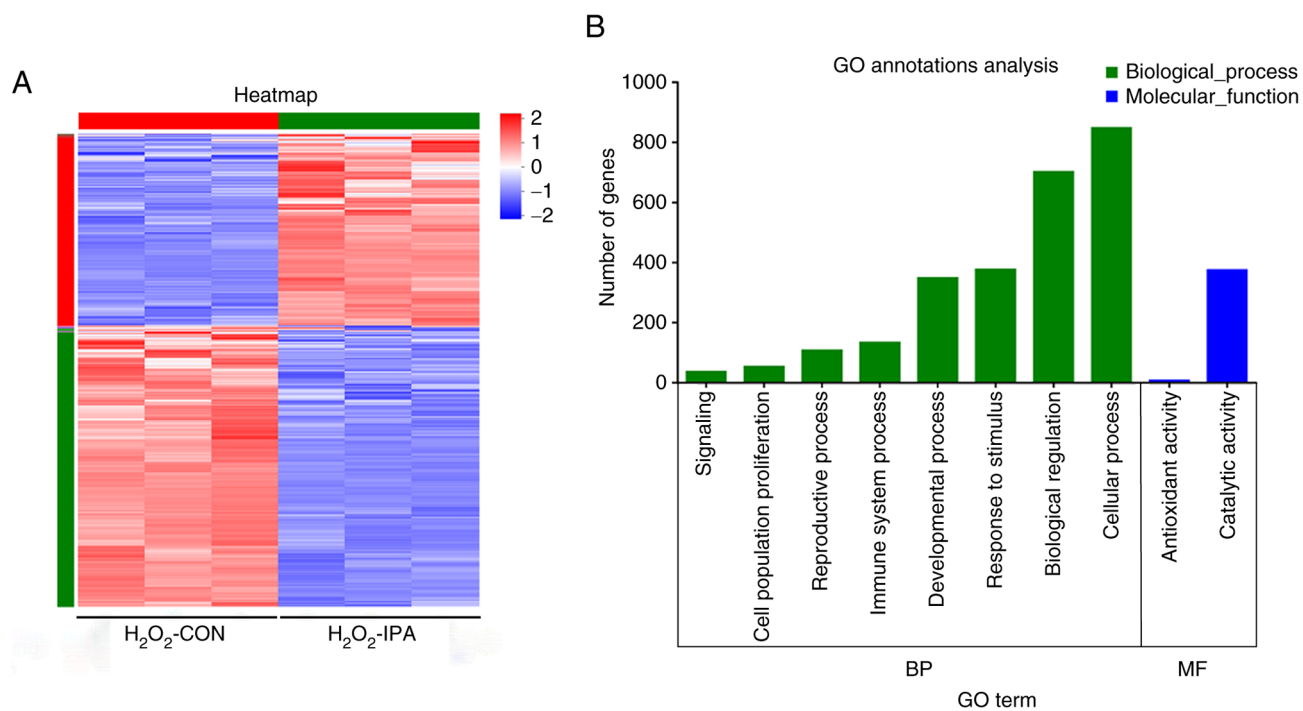


Figure S7. Representative H&E staining images of the heart, liver, spleen, lung, and kidney from the four experimental groups. Data are presented as the mean \pm SD (n=6 per group). IPA, indole-3-propionic acid; OVX, ovariectomy.

