Biomimetic differently structured and multi-branched hydrogel tubes inspired by bud-growth of plant

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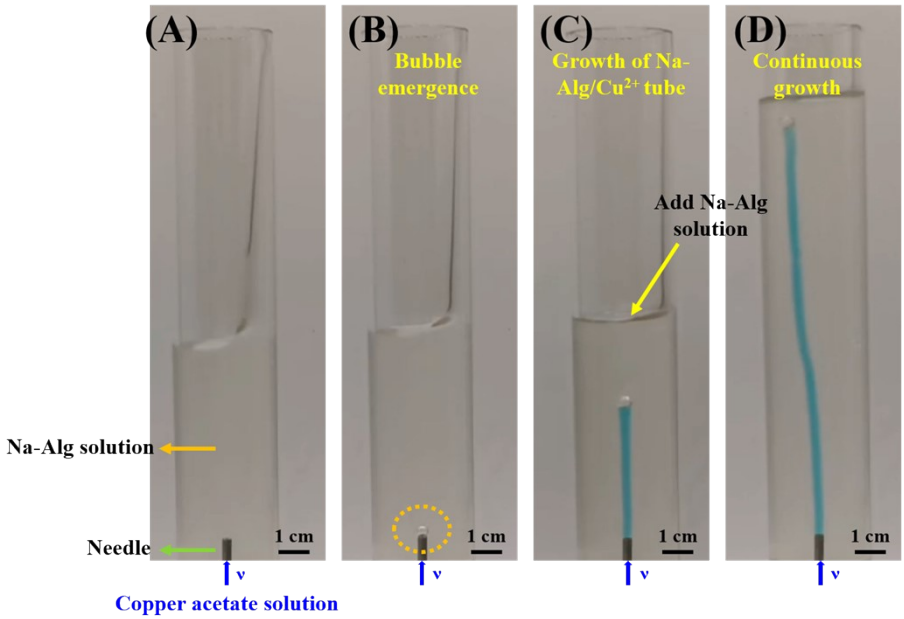

Figure S1. Digital images of the preparation process for hydrogel tubes in the presence of inert material ("air" in this work).

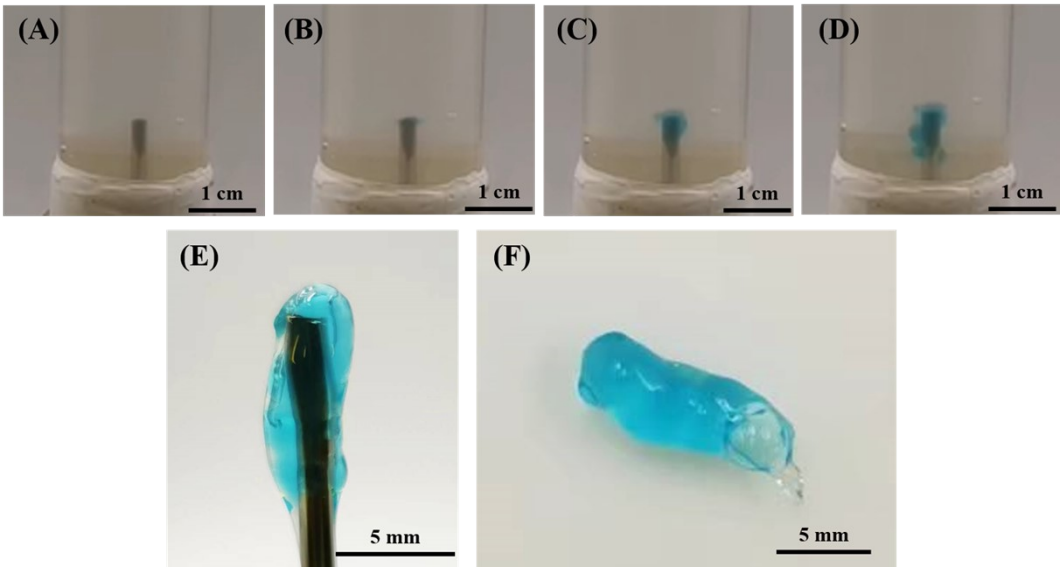

Figure S2. Preparation of hydrogel tubes in the absence of inert material ("air" in this work). (A-D) Digital images showed that the gel evolution at the needle during extrusion of Cu^{2+} solution; (E) Gel at the needle; (F) Gel that peeled off from the needle.

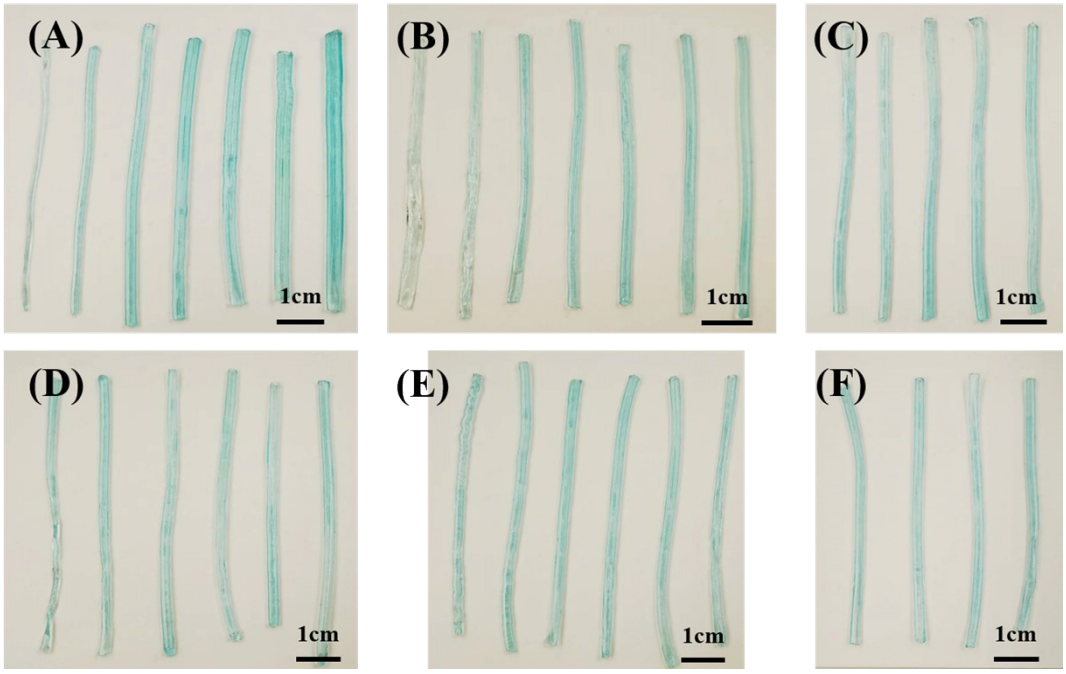

Figure S3. Optical photography of the as-prepared Na-Alg/Cu^{2+} hydrogel tube under different conditions. (A) Concentration of Na-Alg (from left to right: 1 wt%, 1.5 wt%, 2 wt%, 2.5 wt%, 3 wt%, 3.5 wt%, 4 wt%); (B) Concentration of Cu^{2+} (from left to right: 1 wt%, 2 wt%, 3 wt%, 4 wt%, 5 wt%, 6 wt%, 7 wt%); (C) Post-crosslinking time (from left to right: 1 min, 2 min, 3 min, 4 min, 5 min); (D) Extrusion speed (from left to right: 50 μL/min, 100 μL/min, 150 μL/min, 200 μL/min, 250 μL/min, 300 μL/min); (E) Volume of bubble (from left to right: 5 μL, 10 μL, 15 μL, 20 μL, 25 μL, 30 μL); (F) Nozzle size (from left to right: 13G, 15G, 17G, 19G).

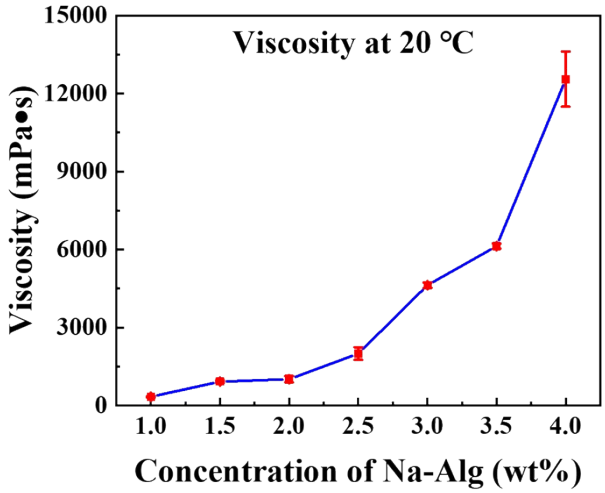

Figure S4. Plot of viscosity with different concentration of Na-Alg at 20 ℃.

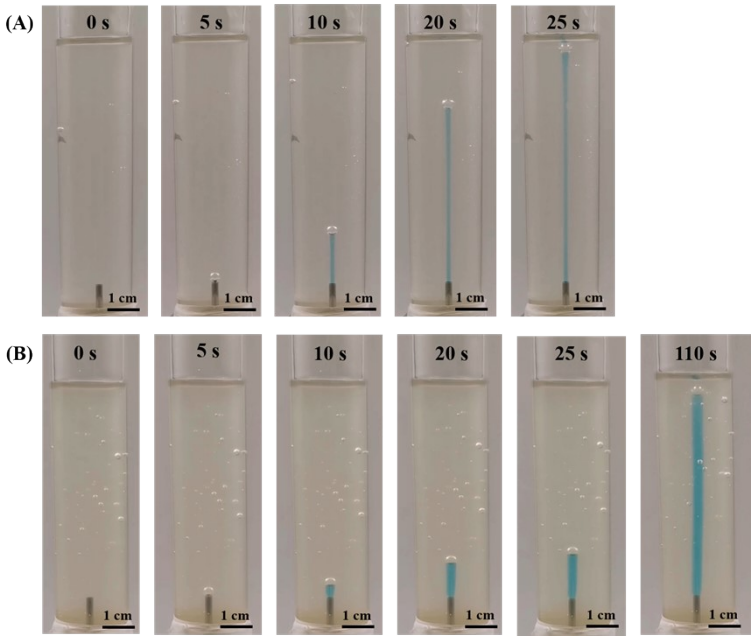

Figure S5. Digital images of tube growth over time under different concentration of Na-Alg, (A) 1.5 wt% Na-Alg; (B) 4 wt% Na-Alg.

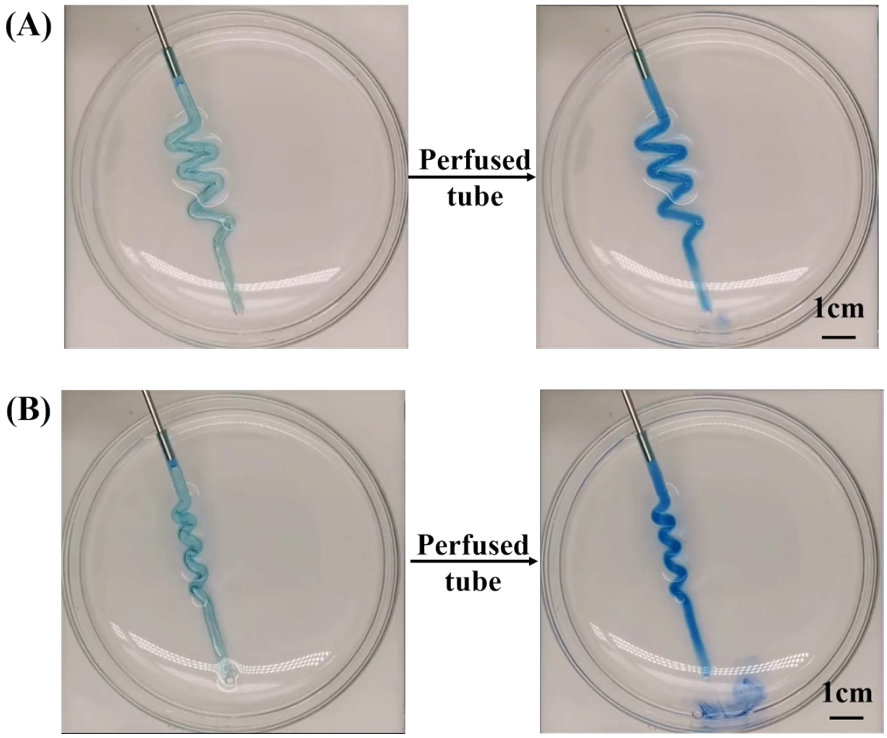

Figure S6. Digital images showed the as-prepared tubes with zigzag-shaped (A) and helical-shaped (B) were perfused.

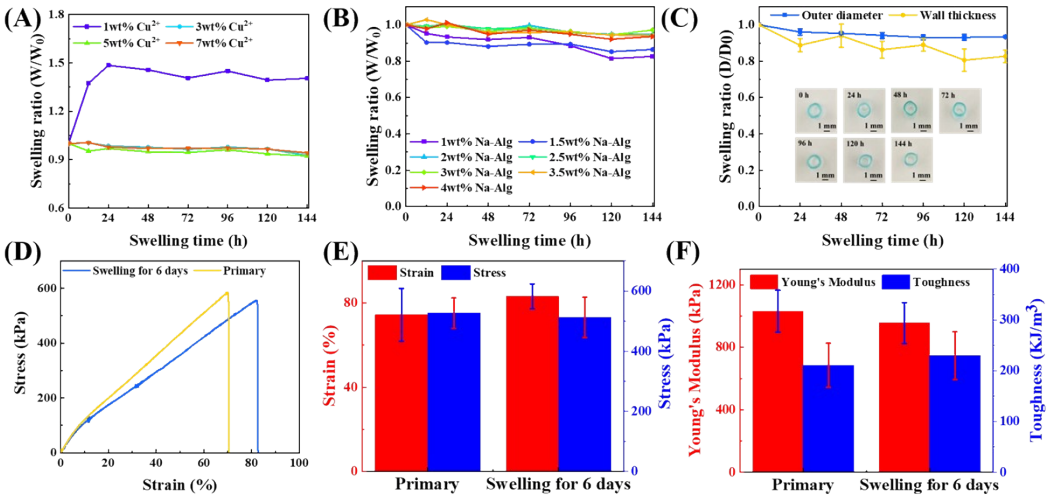

Figure S7. Swelling behavior of the as-prepared tubes. (A) Swelling ratio (W/W_0) of the as-prepared tubes under different concentration of Cu^{2+} (concentration of Na-Alg: 2 wt%; post-crosslinking time: 2 min); (B) Swelling ratio (W/W_0) of the as-prepared tubes under different concentration of Na-Alg (concentration of copper acetate: 5 wt%; post-crosslinking time: 2 min); (C) Swelling ratio (D/D_0) of the as-prepared tubes (concentration of Na-Alg: 2 wt%; concentration of copper acetate: 5 wt%; post-crosslinking time: 2 min), and the physical pictures (the inset graph); (D) Strain-stress curves, (E) Histogram of the strain and stress changes and (F) Histogram of the Young's modulus and toughness changes for the as-prepared hydrogel tubes before and after swelling for 6 days.

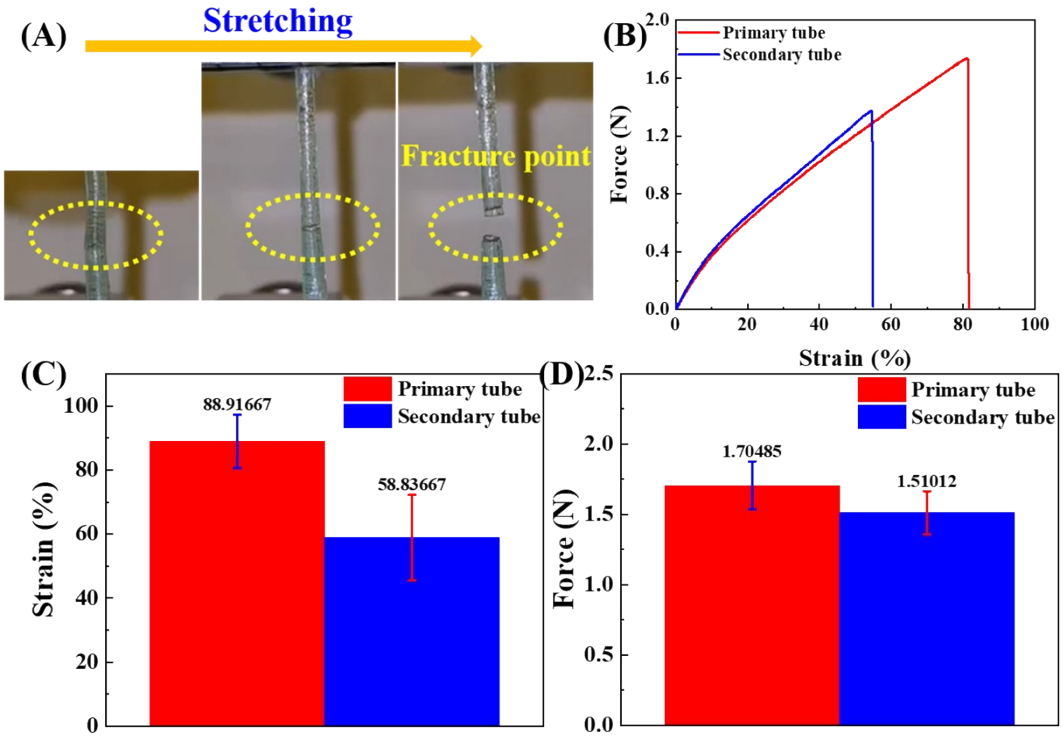

Figure S8. Mechanical properties of the as-prepared secondary Na-Alg/Cu^{2+} hydrogel tubes. (A) Pictures of the as-prepared secondary Na-Alg/Cu^{2+} hydrogel tubes during the stretching process; (B-D) Comparison of mechanical properties of the secondary Na-Alg/Cu^{2+} hydrogel tubes prepared by "secondary growth" and the primary tube.

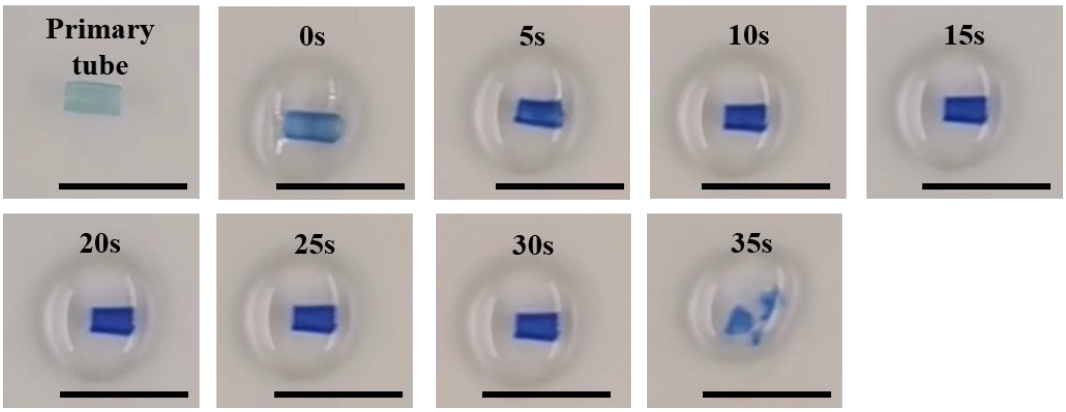

Figure S9. Digital images showed the de-crosslinking of Na-Alg/Cu^{2+} hydrogel by ethanolamine (scale bar: 1 cm).

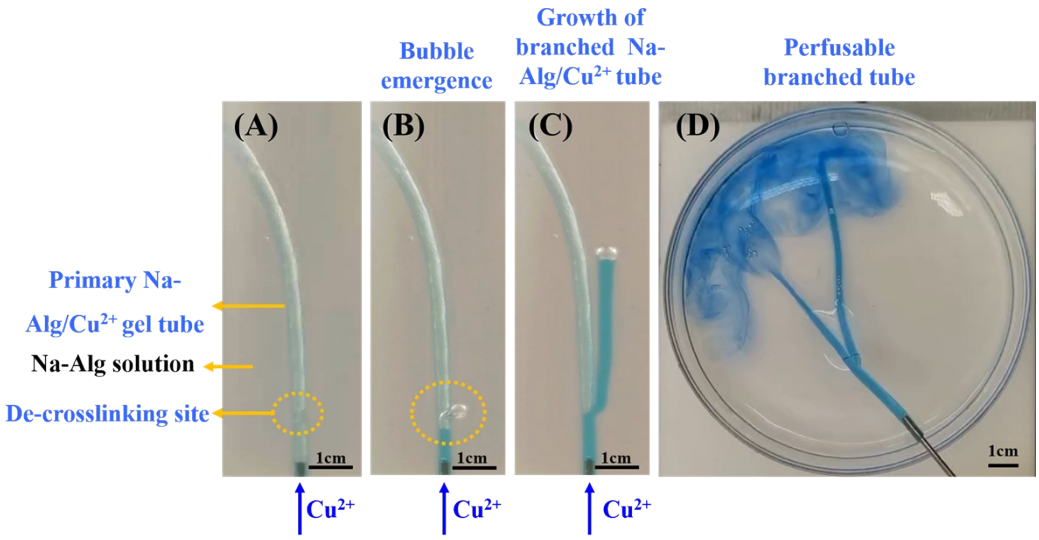

Figure S10. Digital images of the process for multi-branched Na-Alg/Cu^{2+} hydrogel tubes (A-C) and the perfused branched hydrogel tube (D).

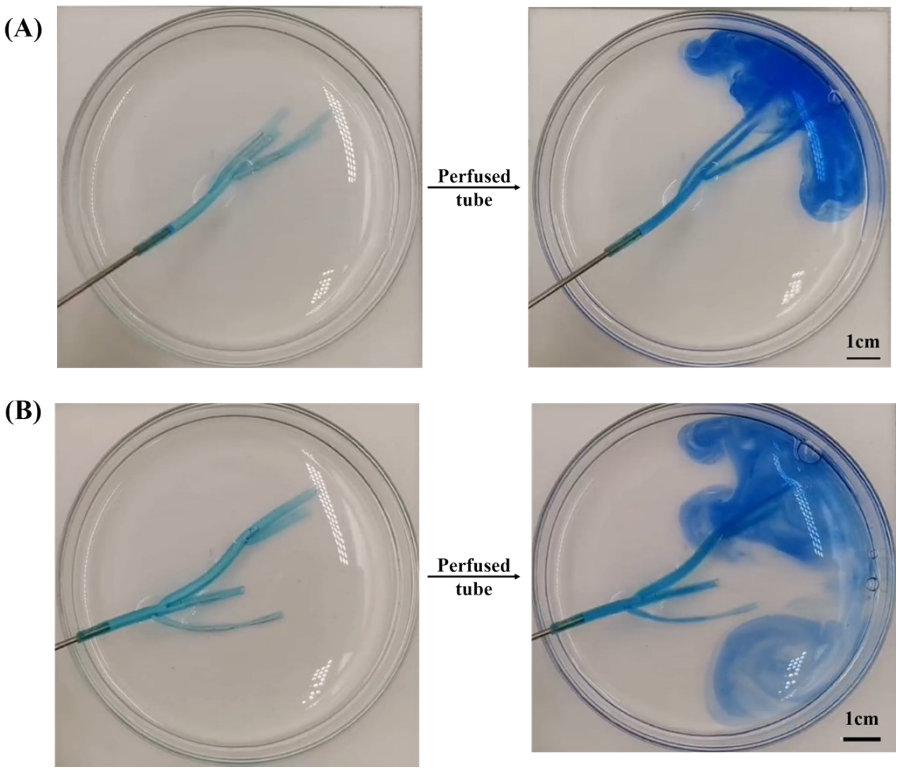

Figure S11. Digital images showed the as-prepared multi-branched tubes were perfused.