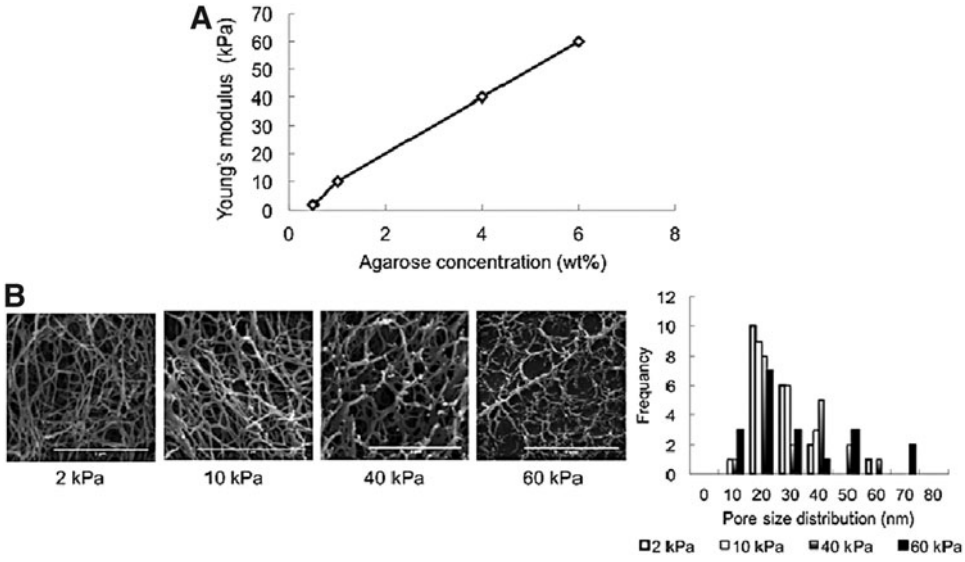
Supplementary Data

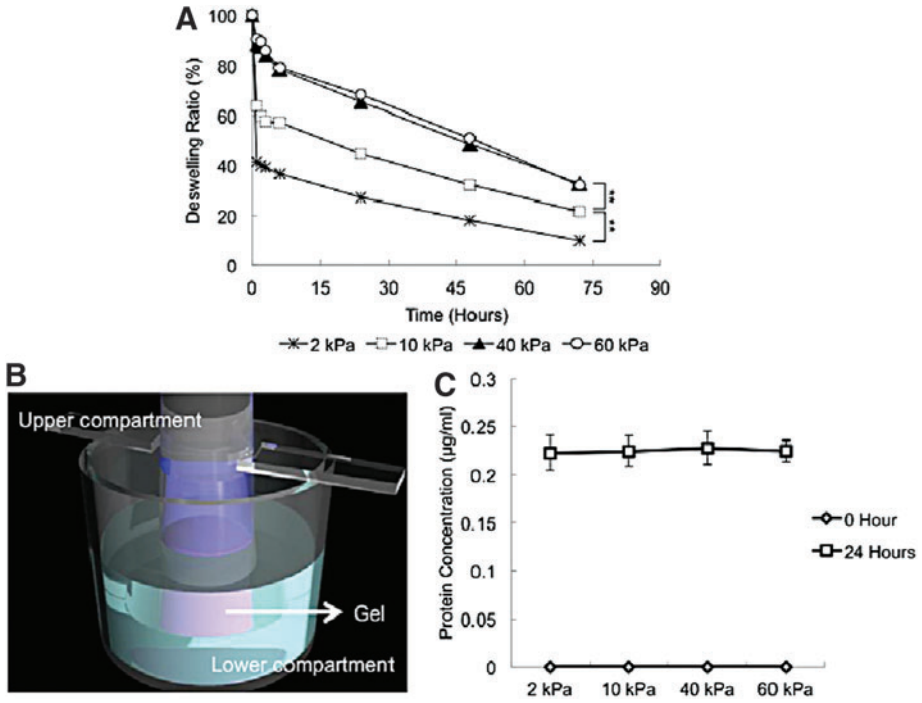
Supplementary Methods

We carried out Young's modulus measurements of synthesized gel by following the Japan Industrial Standard, JIS K6503-1996. Briefly, the prepared hydrogel was compressed by using a mechanical tester (EZ test, Cross-head speed: 1 mm/min). The force value obtained at 2 mm from the gel top after compression was applied to the following equation.

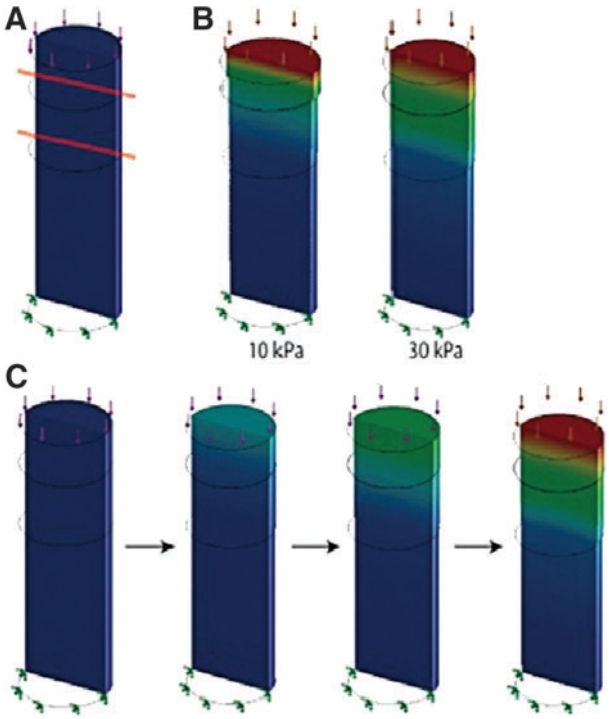
$$\text{Young's modulus(Pa)} = \text{force (N)}/\text{surface area (mm}^2\text{)}$$



SUPPLEMENTARY FIG. S1. **(A)** Graph showing the effect of agarose concentration on the Young's modulus of agarose hydrogel. **(B)** Scanning electron microscopy showed nanoporous structure of the agarose hydrogel (scale bar = 1 μm). Graph depicting the frequency of the pore sizes distribution inside the hydrogel ($n = 3$).



SUPPLEMENTARY FIG. S2. **(A)** Graph depicting the deswelling ratio of the agarose hydrogel (**$p < 0.001$) ($n = 5$). **(B)** Schematic diagram of the modified two-compartment system for gel permeability. Upper compartment filled with gel and protein substrate. Pink color represents gel, blue color represents protein. Lower part filled with distilled water. **(C)** Permeability of the different concentrated hydrogel ($n = 4$).



SUPPLEMENTARY FIG. S3. **(A)** Finite element analysis of the bone tissue consisting of bone stem, cartilaginous bone head, and the attached hydrogel. **(B)** The displacement of tissue was especially observable in the cartilaginous bonehead region, but not the bone stem region. **(C)** The displacement of cartilage tissue attaching to the gel with different Young's modulus (*left*; 10 kPa, *right*; 30 kPa).