Supplemental Information

Mapping single-cell rheology of ascidian embryos in the cleavage stages using AFM

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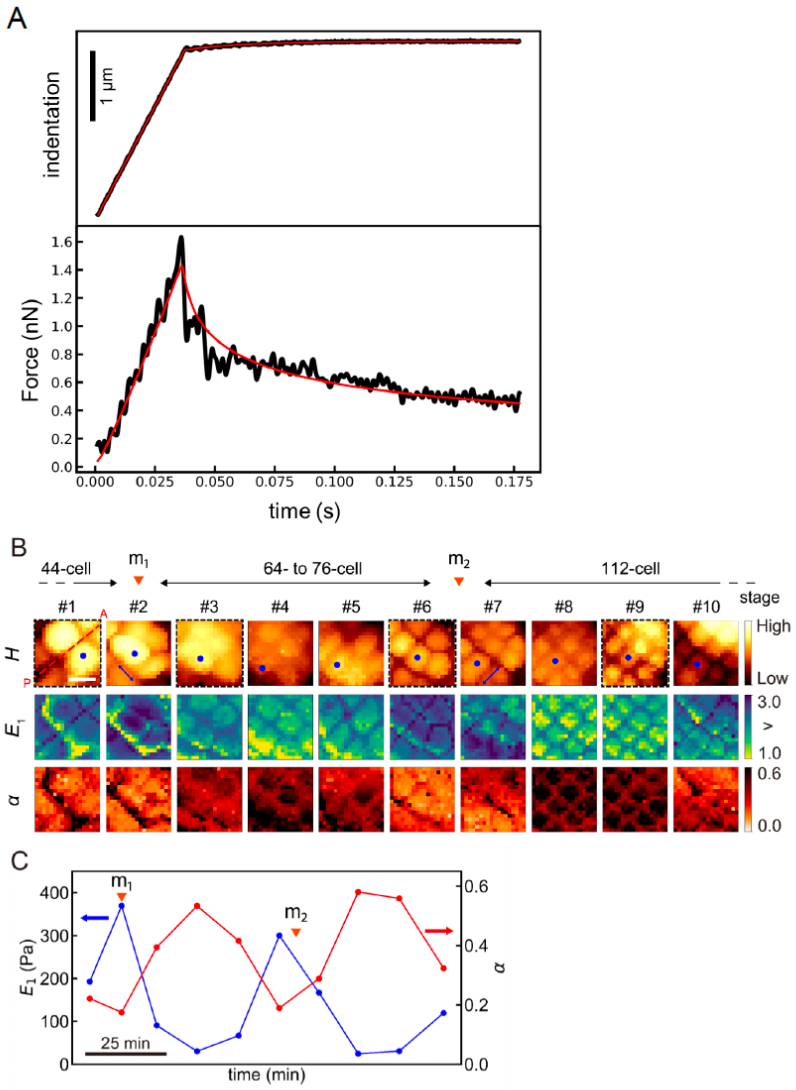

FIGURE S1 (*A*) Indentation depth δ and force as a function of time in the initial stress relaxation stage shown in Fig. 1*C*, where δ was an increasing function. The δ in the hold phase was fitted to a single exponential function with constant components, while the δ in the approach phase was the linear same as that in Fig. 1*C*. The force was fitted with Eq. 3 using the time-dependent δ. The black dots and the red lines represent the measured data (Fig. 1*C*) and the fitted result, respectively. (*B*) The relative height H, modulus scaling factor E_1, and power law exponent α images of the embryo presented in Fig. 2*C* were analyzed using Eq. 3 using the time-dependent δ in the hold phase (*A*). Tracked cells were indicated by dots (*blue*). Scale bar, 30 μm. (*C*) Plots of geometrically averaged E_1 (*blue*) and arithmetic averaged α (*red*) around the center of cells imaged in (*B*).

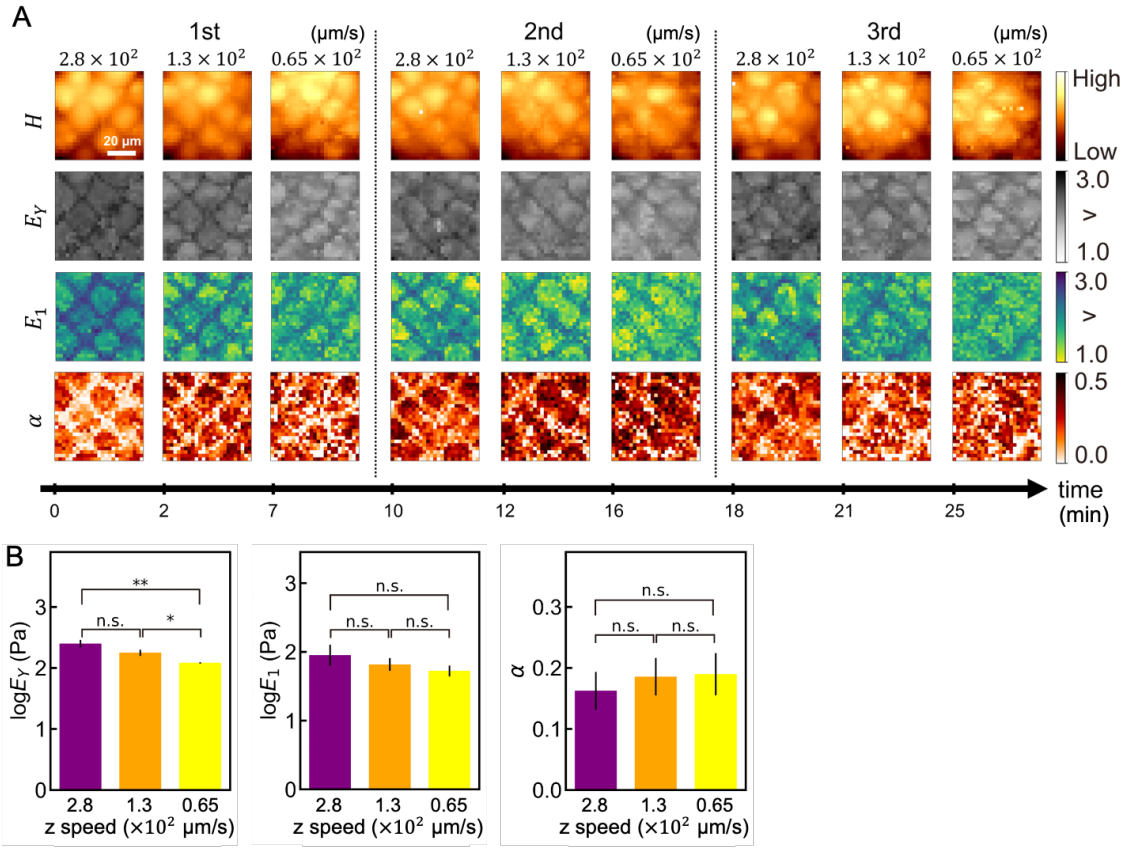

FIGURE S2 (*A*) Approach-retraction AFM images of H, E_Y, E_1, and α of ascidian embryo in the animal hemisphere from the 64-cell to 76-cell stages. We obtained three mapping images in almost the same regions by setting the z-scan speed to 2.8×10^2, 1.3×10^2, and 0.65×10^2 μm/s in each mapping image. The AFM mapping experiments were replicated thrice (denoted as 1st, 2nd, and 3rd). The time represents the time from which the initial mapping experiment was started. (*B*) Quantifications of E_Y, E_1, and α values of embryonic cells in different z-scan speeds. Data are arithmetic mean ± s.d. estimated from images in (*A*). An unpaired two-tailed Student's t-test was used to determine P values. *$P < 0.05$, **$P < 0.01$.

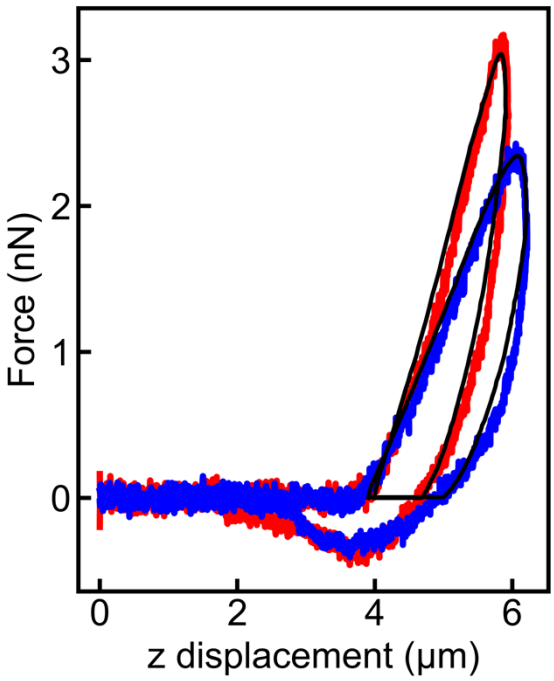

FIGURE S3 An example of approach-retraction AFM force curves in different rheological states around the normalized time of 0.30 (*red*) and 0.75 (*blue*). The black lines represent the fitted results with Eqs. 5 and 6.