Electronic Supporting Information

# Multilamellar ceramide core-structured microvehicles with substantial skin barrier function recovery

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## Supporting experiments

### Cell viability test

Cell viability was measured using an EZ-Cytox kit (EZ-3000, Dogen, Korea). Human HaCaT cells were dispersed in 100 µL of DMEM (4 mM of L-glutamine, 4500 mg $mL^{-1}$ of glucose, 90% sodium pyruvate, 10% heat inactivated fetal bovine serum, and 1% penicillin–streptomycin) in a 96-well plate. HaCaT cells were then incubated overnight at 37 °C under 5% $CO_2$ atmosphere in an incubator. After removal of cell media, $BCNF_{C18}$ and Cer dispersions were added to each well with varying their concentration. Then, 100 µL of EZ-cytox and DMEM mixture were added to the wells. The plates were incubated for an additional 24 h and UV absorbance was measured at 450 nm using a microplate reader (Spark, Tecan, Switzerland).

## Supporting data

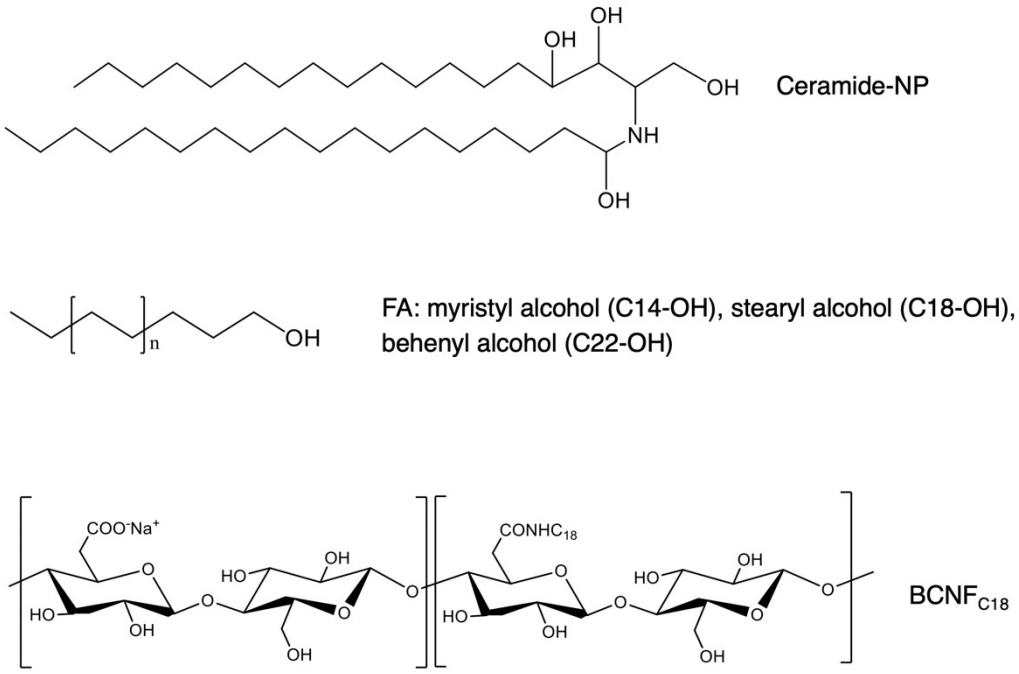


**Fig. S1** Molecular structure of ceramide, fatty alcohols, and $BCNF_{C18}$ employed for the fabrication of CerMPs.

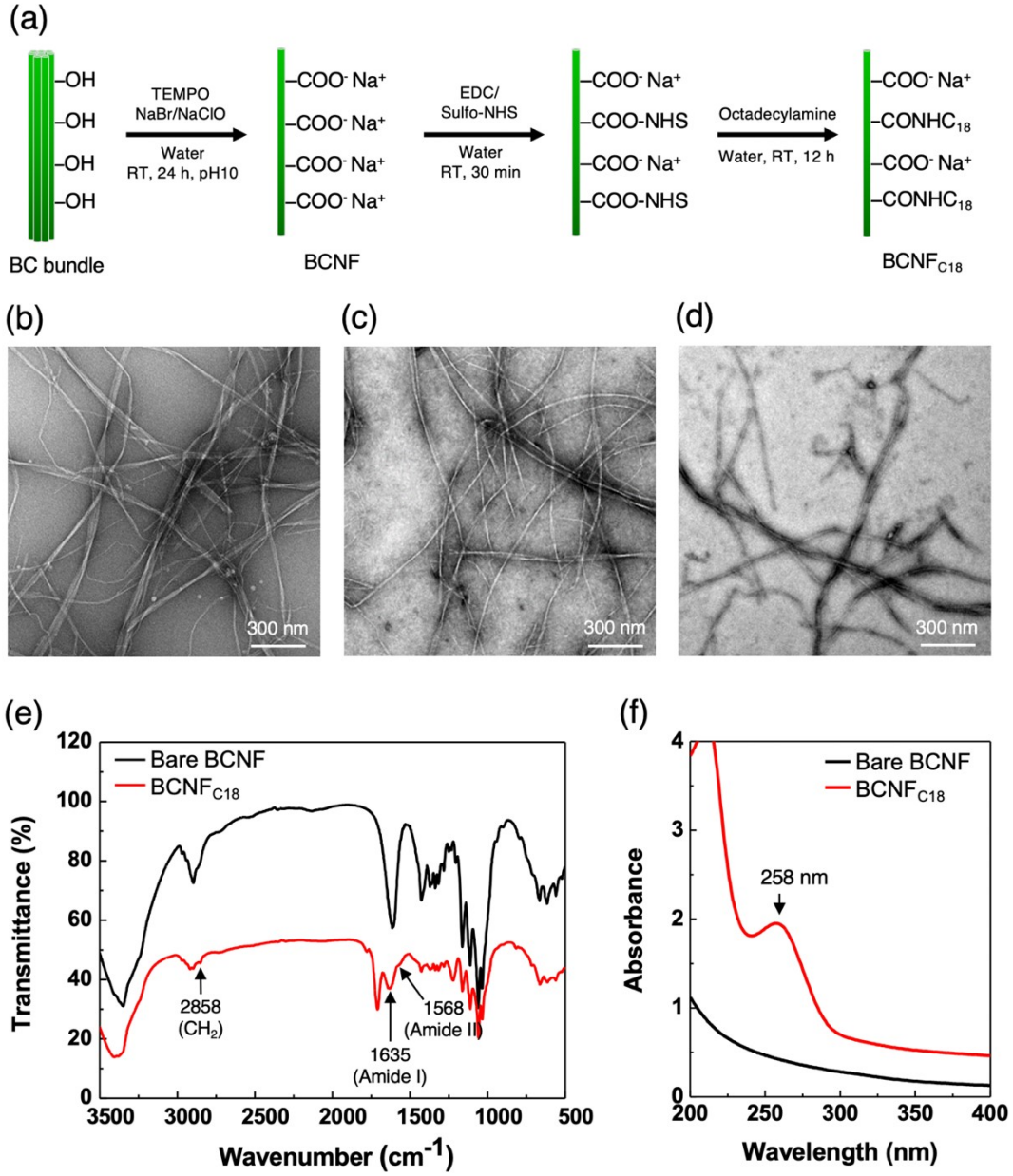


**Fig. S2** (a) Synthesis of $BCNF_{C18}$ from a bacterial cellulose bundle. TEM images of bacterial celluloses (b) before and (c) after TEMPO oxidation, and (d) after grafting of C18 alkyl chains. (e) FT-IR spectra and (f) UV spectra of BCNFs before and after grafting of C18 alkyl chains.

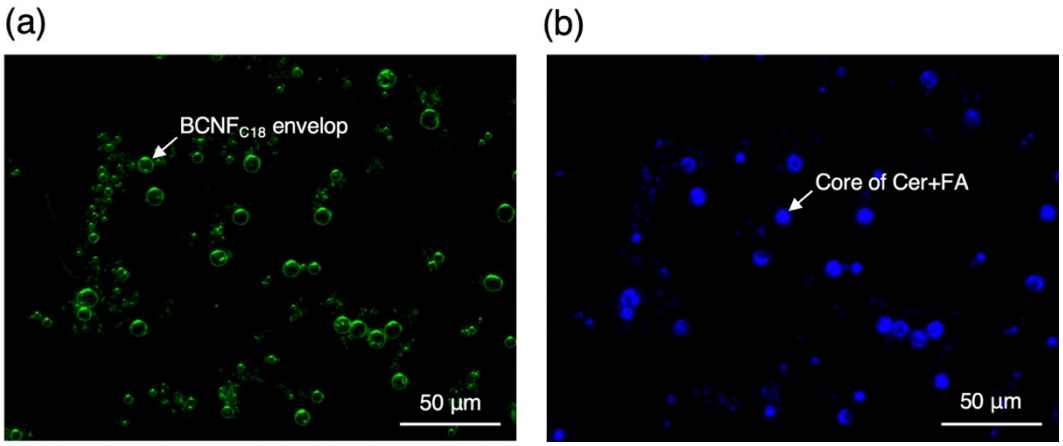


**Fig. S3** Fluorescence images of CerMPs labelled with (a) rhodamine B for $BCNF_{C18}$ membrane (green) and (b) 9-vinylanthracene for particle core (blue). $\phi_{Cer}$ = 0.4, [Ceramide NP+SA] = 20 wt%, and $[BCNF_{C18}]$ = 0.5 wt%.

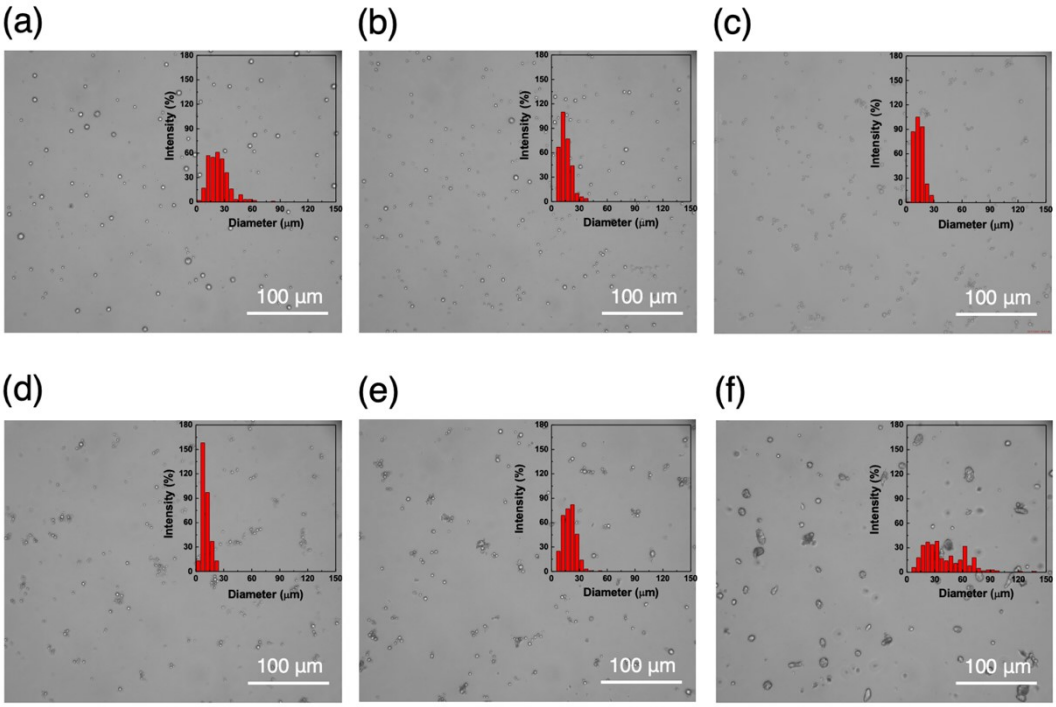


**Fig. S4** Bright-field microscope images and particle size distribution of CerMPs with varying the incorporation amount of C18 alkyl chain against total mass of Ceramide NP and FA: (a) 0.08 mmol $g^{-1}$, (b) 0.16 mmol $g^{-1}$, (c) 0.48 mmol $g^{-1}$, (d) 0.64 mmol $g^{-1}$ g, (e) 0.96 mmol $g^{-1}$, and (f) 1.28 mmol $g^{-1}$ octadecylamine. $\phi_{Cer}$ = 0.4, [Ceramide NP+SA] = 20 wt%, and $[BCNF_{C18}]$ = 0.5 wt%.

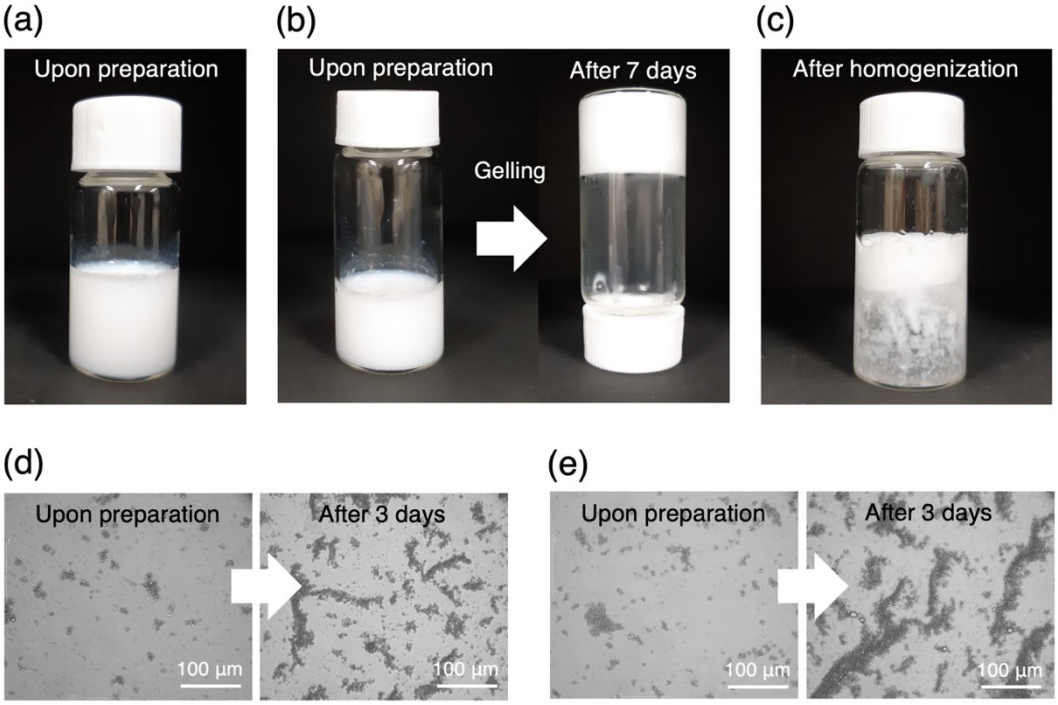


**Fig. S5** Appearances CerMP dispersions prepared with conventional molecular surfactants: (a) Pluronic F127, (b) Tween 80, and (c) SLS. $\phi_{Cer}$ = 0.2, [Ceramide NP+SA]=20 wt%, and [Surfactant] = 5 wt%. Destabilization behavior of CerMPs prepared with Pluronic F127 with the storage time at 4 °C: (d) [Pluronic F127] = 3 wt% and (e) [Pluronic F127] = 5 wt%. $\phi_{Cer}$ = 0.2 and [Ceramide NP+SA] = 20 wt%.

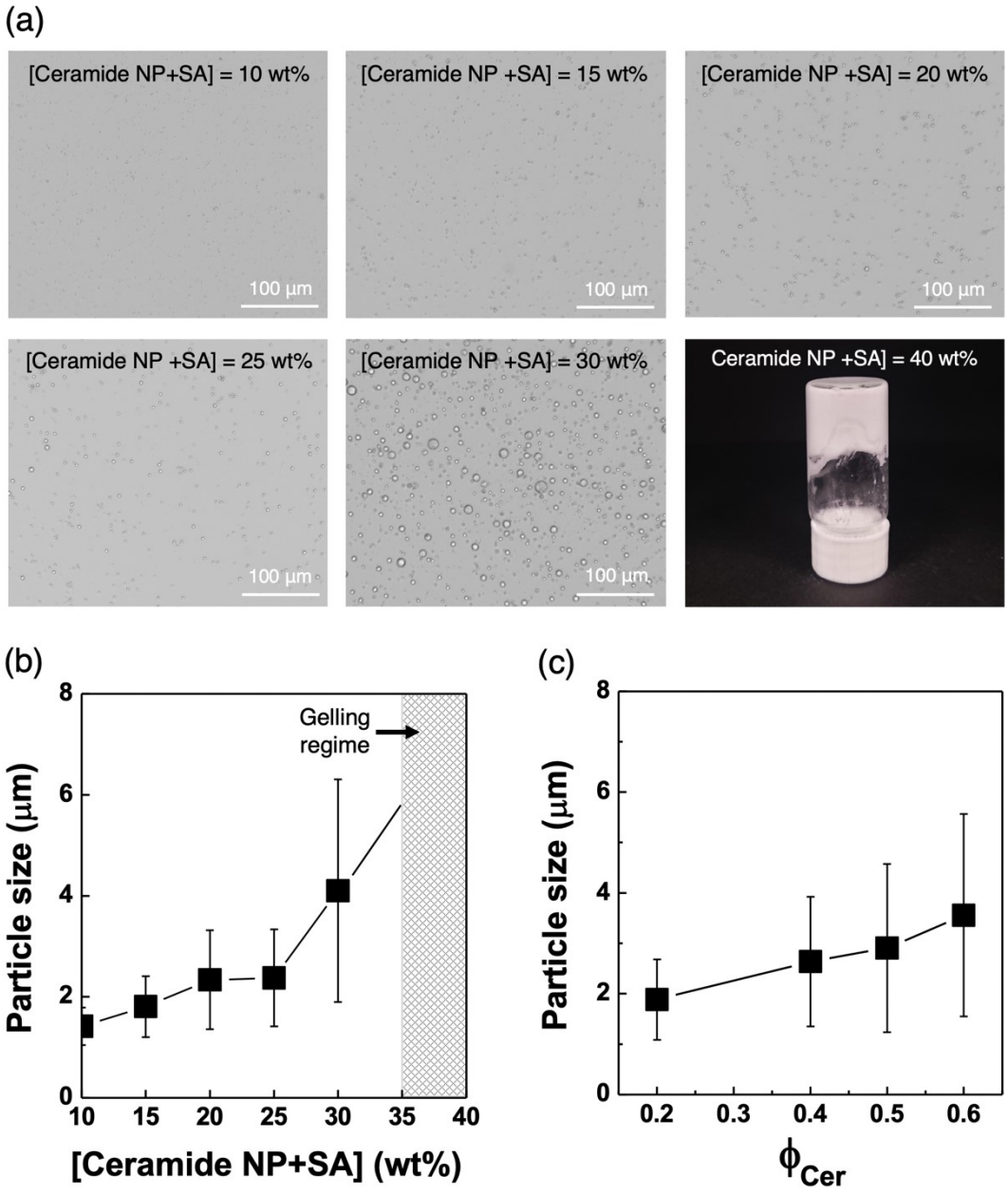


**Fig. S6** (a) Bright-field microscope images of CerMPs with varying the solid (Ceramide NP + SA) concentration. A gel-like dispersion phase was obtained from around 35 wt%. Average particle size change of CerMPs with varying (b) the core content at $\phi_{Cer}$ = 0.4 and (c) the $\phi_{Cer}$ at [Ceramide NP+SA] = 20 wt%. [$BCNF_{C18}$] = 0.5 wt%.

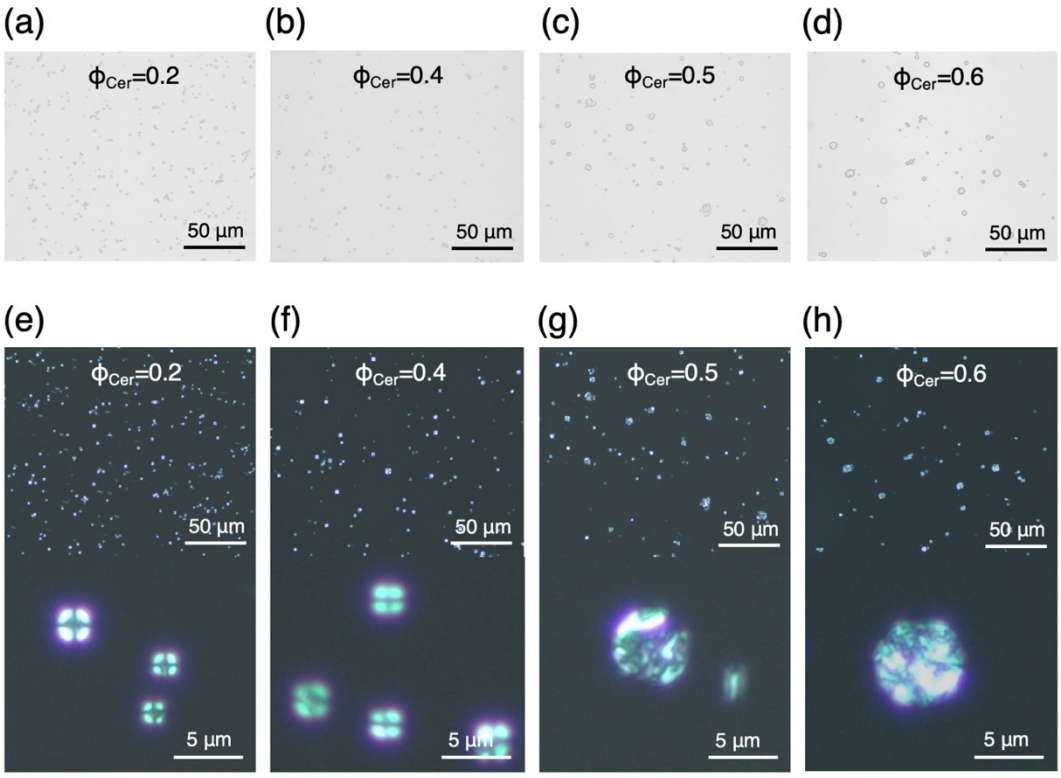


**Fig. S7** Bright-field microscope (a-d) and polarized microscope images (e-h) of CerMPs prepared with varying $\phi_{Cer}$ after 6-month storage at 4 °C. [Ceramide NP+BA] = 20 wt% and [$BCNF_{C18}$] = 0.5 wt%.

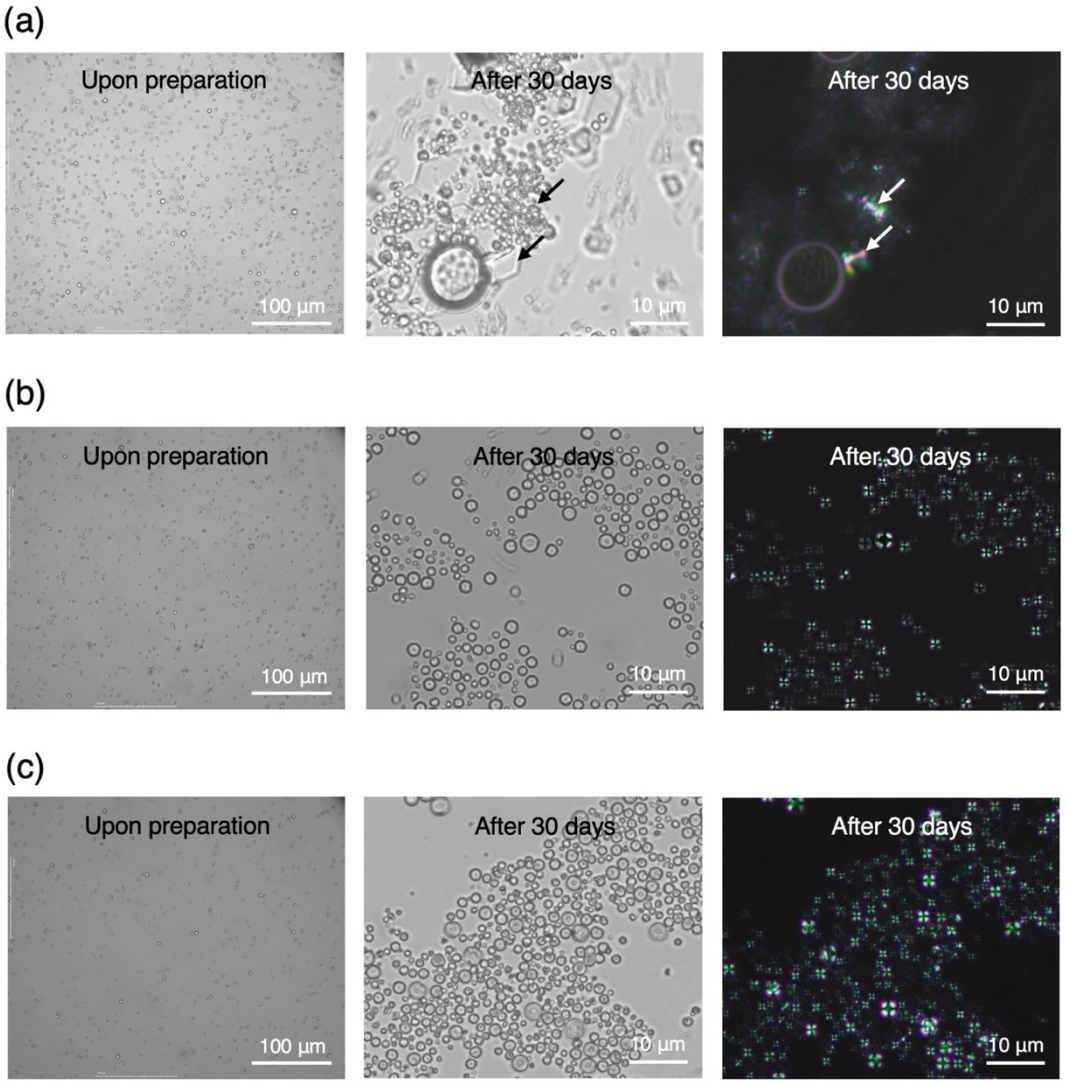


**Fig. S8** Bright-field microscope images and polarized microscope images of CerMPs upon preparation and after 30-day storage at 4 °C: (a) $CerMP_{MA}$, (b) $CerMP_{SA}$, and (c) $CerMP_{BA}$. Arrows indicate ceramide crystals grown out of $CerMP_{MA}$ in the aqueous phase. $\phi_{Cer}$ = 0.4, [Ceramide NP+FA] = 20 wt%, and [$BCNF_{C18}$] = 0.5 wt%.

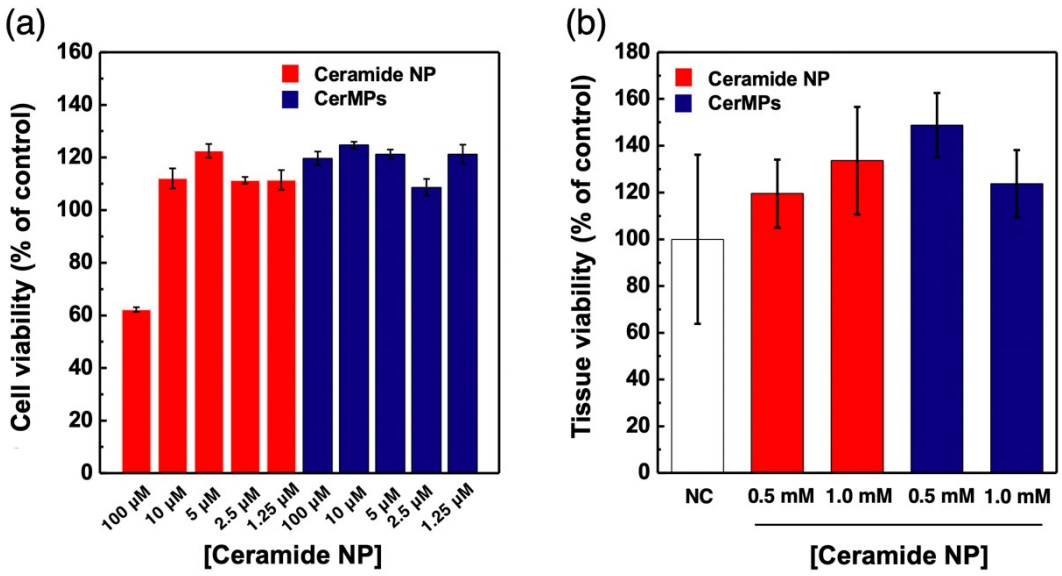


**Fig. S9** (a) Cell viability after treating HaCaT cells with Ceramide NP dispersions (red) and CerMP dispersions (blue) for 24 h incubation. (b) Tissue viability determined by WST-1 assay after 4 h treatment with Ceramide NP dispersions (red) and CerMP dispersions (blue) at given concentrations. Data were expressed as a normalized percentage of non-treated control cells (NC) after three independent experiments. Error bars represent standard deviation of the mean (n = 6) ($p < 0.05$, one-way ANOVA).

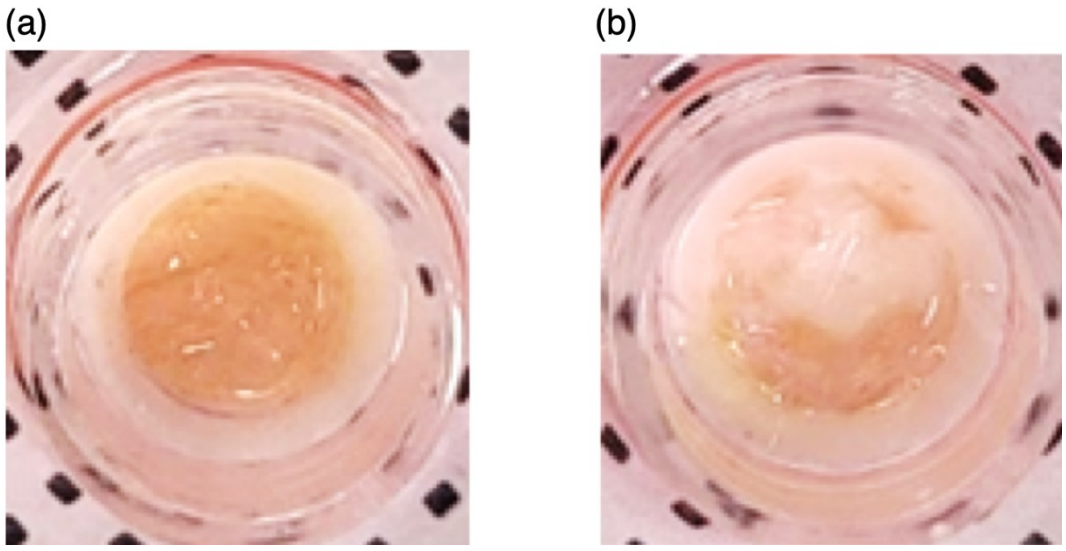


**Fig. S10** (a) Normal porcine tissue. (b) $H_2O_2$-induced damaged porcine tissue.