

**Supplementary Information**  
**Preparation of Peptoid Antifreeze Agents and Their**  
**Structure-Property Relationship Study**

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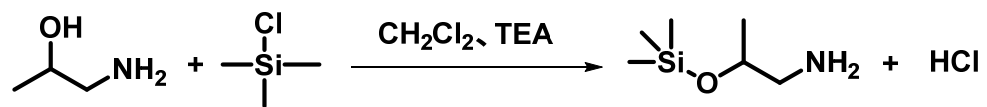
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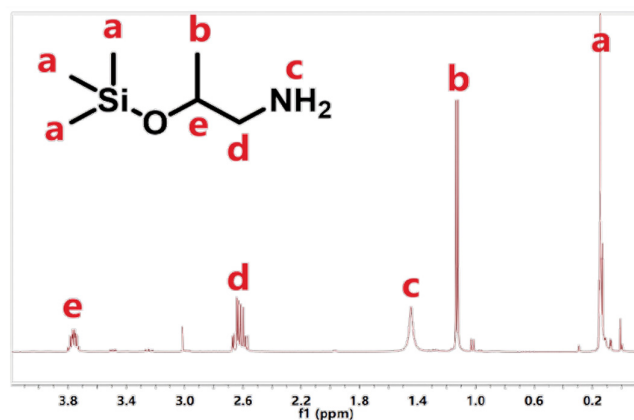
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## 1. Monomer synthesis and characterization

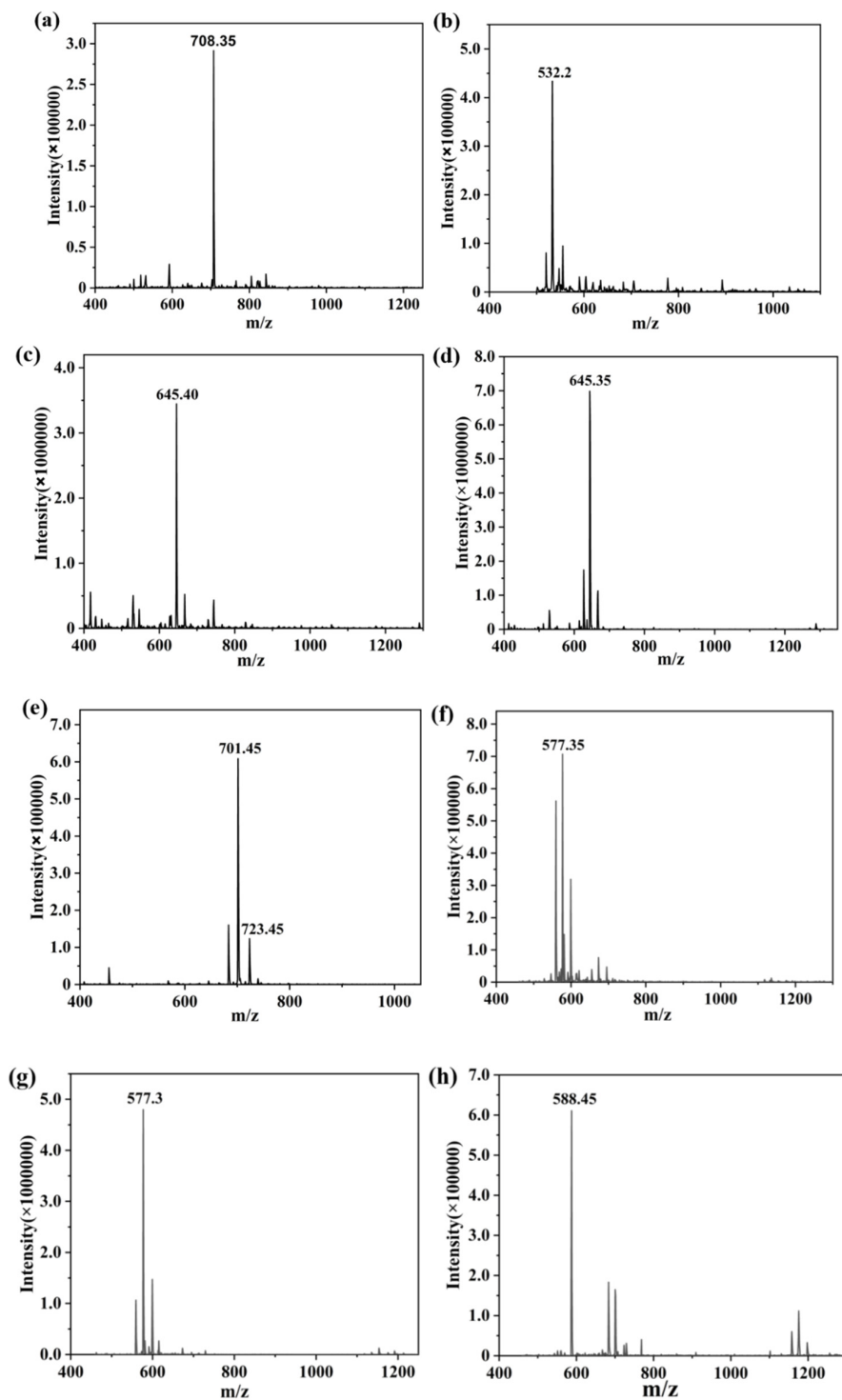


**Scheme S1** Synthesis route of submonomer 3-trimethylsilanoxy-propylamine.



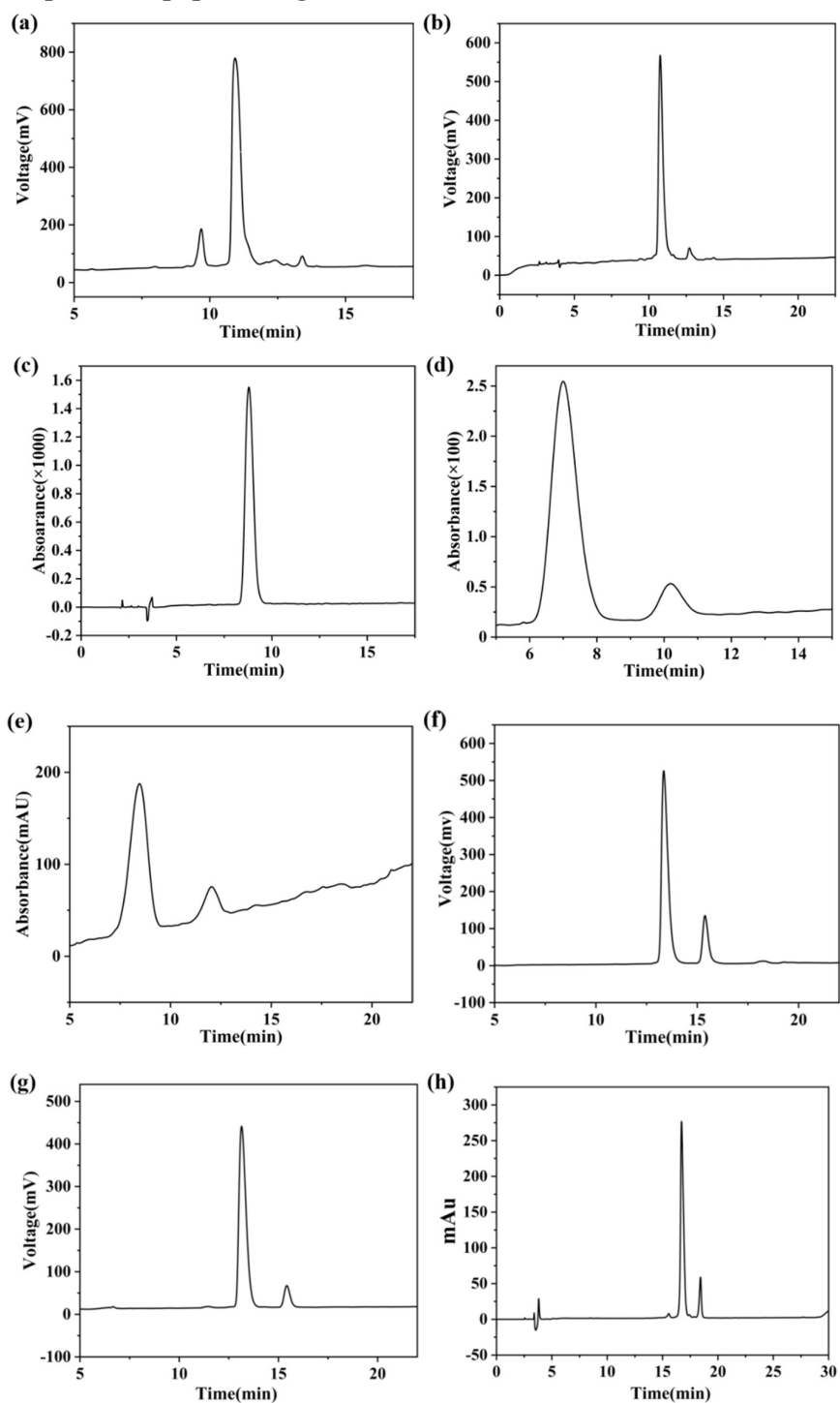
**Fig. S1** <sup>1</sup>H NMR spectrum of 3-trimethylsilanoxy-propylamine in CDCl<sub>3</sub>

## 2. MS spectra of peptoid oligomers



**Fig. S2** MS spectra of peptoid oligomers. (a) P-(Nis)<sub>6</sub>; (b) P-[Nis-(Nme)<sub>2</sub>]<sub>2</sub>; (c) P-[Nis-(Net)<sub>2</sub>]<sub>2</sub>; (d) P-[Nis-(Npr)<sub>2</sub>]<sub>2</sub>; (e) P-[Nis-(Nip)<sub>2</sub>]<sub>2</sub>; (f) P-[Nme-(Nis)<sub>2</sub>]<sub>2</sub>; (g) P-(Nis-Nme)<sub>3</sub>; (h) P-(Nis-Nme)<sub>3</sub>

### 3. HPLC spectra of peptoid oligomers

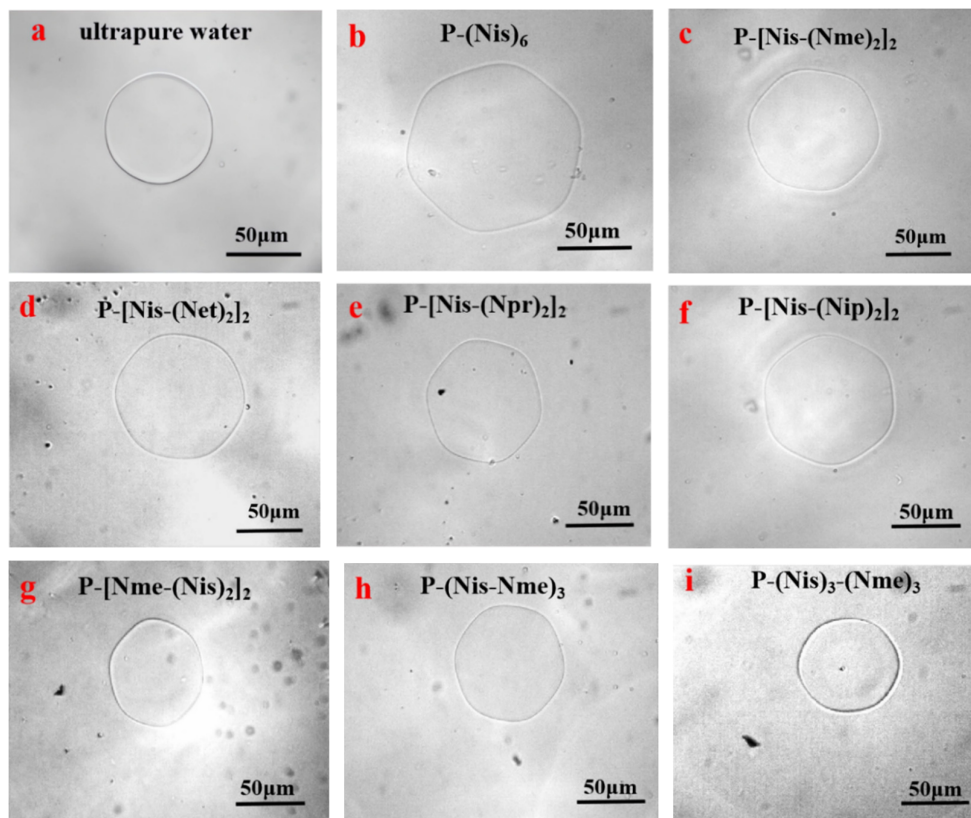


**Fig. S3** HPLC traces after purification of peptoid oligomers. (a) P-(Nis)<sub>6</sub>; (b) P-[Nis-(Nme)<sub>2</sub>]<sub>2</sub>;

(c) P-[Nis-(Net)<sub>2</sub>]<sub>2</sub>; (d) P-[Nis-(Npr)<sub>2</sub>]<sub>2</sub>; (e) P-[Nis-(Nip)<sub>2</sub>]<sub>2</sub>; (f) P-[Nme-(Nis)<sub>2</sub>]<sub>2</sub>; (g) P-(Nis-

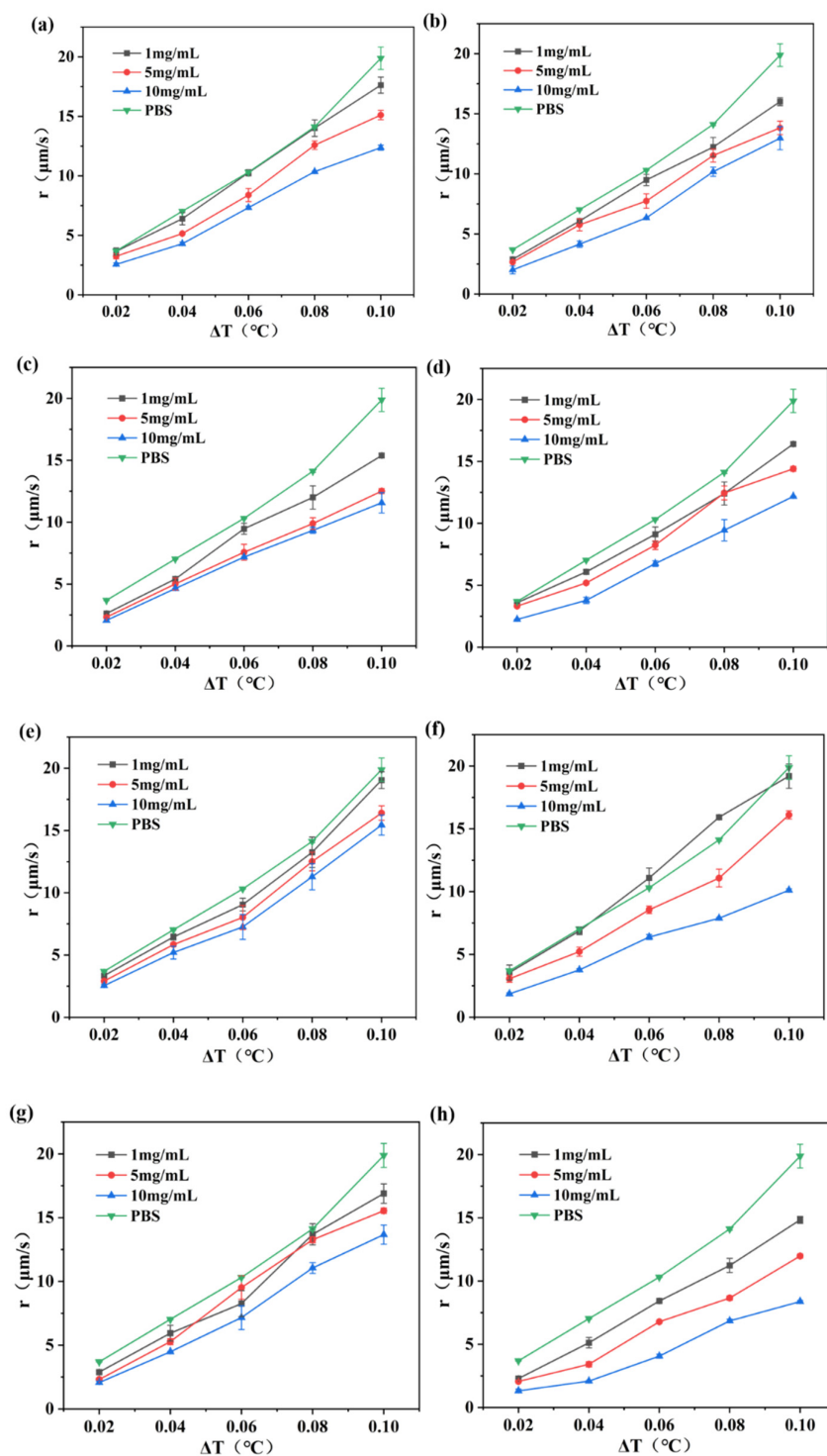
Nme)<sub>3</sub>; (h) P-(Nis-Nme)<sub>3</sub>

#### 4. The morphologies of ice crystals



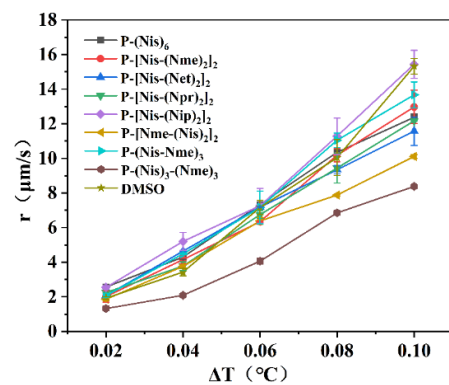
**Fig. S4** Optical images of ice crystal morphology in peptoid solutions and ultrapure water at the concentration of 10 mg/mL ( $\Delta T = 0.08$  °C). (a) ultrapure water; (b) P-(Nis)<sub>6</sub>; (c) P-[Nis-(Nme)<sub>2</sub>]<sub>2</sub>; (d) P-[Nis-(Net)<sub>2</sub>]<sub>2</sub>; (e) P-[Nis-(Npr)<sub>2</sub>]<sub>2</sub>; (f) P-[Nis-(Nip)<sub>2</sub>]<sub>2</sub>; (g) P-[Nme-(Nis)<sub>2</sub>]<sub>2</sub>; (h) P-(Nis-Nme)<sub>3</sub>; (i) P-(Nis-Nme)<sub>3</sub>.

## 5. The growth rates of ice crystals



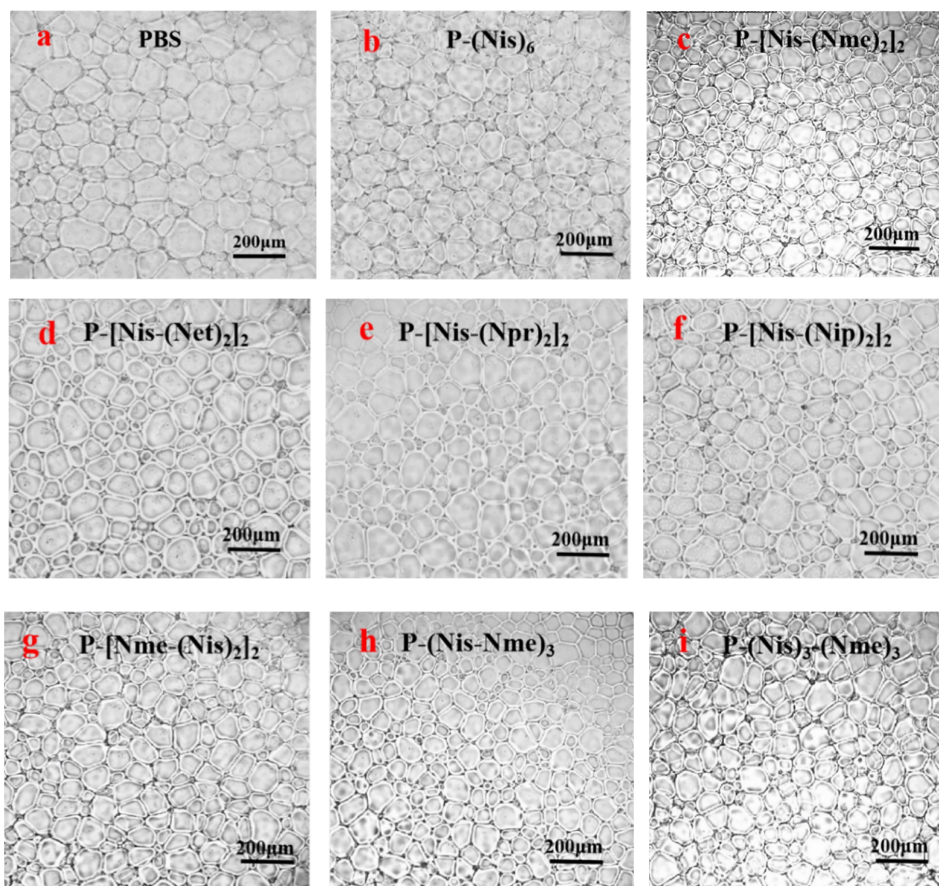
**Fig. S5** Comparison of ice crystal growth rates between peptoid oligomers solutions and PBS

buffer. (a) P-(Nis)<sub>6</sub>; (b) P-[Nis-(Nme)<sub>2</sub>]<sub>2</sub>; (c) P-[Nis-(Net)<sub>2</sub>]<sub>2</sub>; (d) P-[Nis-(Npr)<sub>2</sub>]<sub>2</sub>; (e) P-[Nis-(Nip)<sub>2</sub>]<sub>2</sub>; (f) P-[Nme-(Nis)<sub>2</sub>]<sub>2</sub>; (g) P-(Nis-Nme)<sub>3</sub>; (h) P-(Nis-Nme)<sub>3</sub>



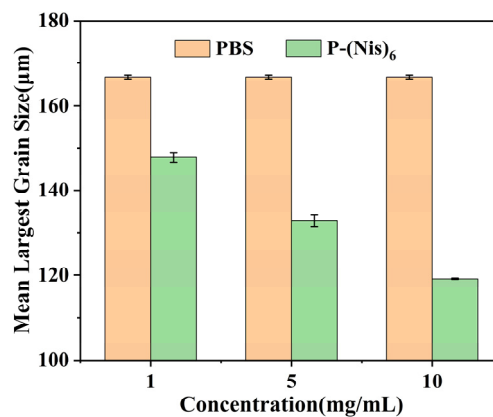
**Fig. S6** The ice crystal growth rates of all peptoid and DMSO solutions at the concentration of 10 mg/mL.

## 6. Ice recrystallization inhibition activities of peptoid oligomers

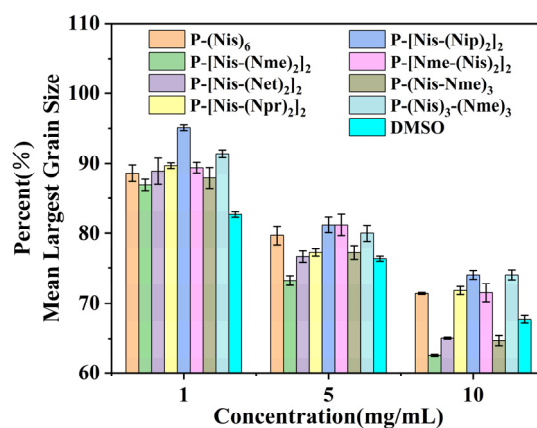


**Fig. S7** Micrographs of ice crystals grown in 10 mg/mL solution of peptoid solutions and PBS buffer.

(a) PBS; (b) P-(Nis)<sub>6</sub>; (c) P-[Nis-(Nme)<sub>2</sub>]<sub>2</sub>; (d) P-[Nis-(Net)<sub>2</sub>]<sub>2</sub>; (e) P-[Nis-(Npr)<sub>2</sub>]<sub>2</sub>; (f) P-[Nis-(Nip)<sub>2</sub>]<sub>2</sub>; (g) P-[Nme-(Nis)<sub>2</sub>]<sub>2</sub>; (h) P-(Nis-Nme)<sub>3</sub>; (i) P-(Nis-Nme)<sub>3</sub>.



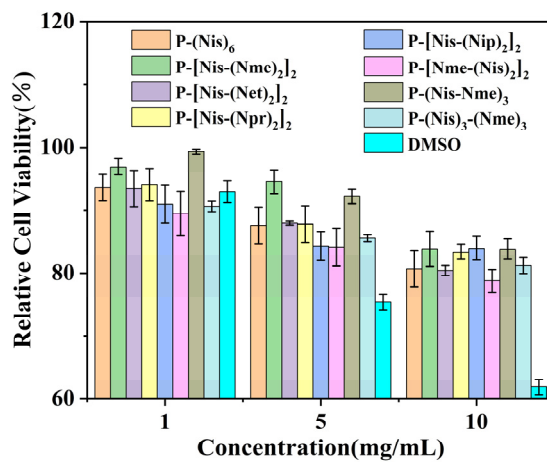
**Fig. S8** The MLGS of P-(Nis)<sub>6</sub> solution were compared with PBS buffer.



**Fig. S9** Percentage of MLGS of ice crystals in PBS buffer after peptides and DMSO solutions

annealing at -6 °C for 30 min.

## 7. Cytotoxicity test results



**Fig. S10** The relative cell viability of peptides and DMSO solutions at different concentrations.