The nature of non-freezing water in biopolymer solutions

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In aqueous environment, biopolymers are surrounded by hydration shell consisting of water molecules that are sometimes called “bound”. There is however no evidence that the water-polymer interaction energy is higher than the water-water interaction energy. Moreover, thermodynamic analysis shows that many biopolymers have positive deviations from ideal behaviour. Still, when polymer solutions are subjected to low temperatures, a part of water turns into ice, another part remains in the polymer phase and is called “nonfreezing water”. A rigorous thermodynamic analysis of water freezing shows that the amount of non-freezing water does not reflect the amount of bound water, neither can it be used as a measure of strength of polymer-water interactions. Upon deep cooling, crystallization of water should desiccate polymers more than is observed in experiment. The reason for existence of non-freezing water is an interplay between the crystallization of water and the glass transition in biopolymers that prevents dehydration. This conclusion is in agreement with recently obtained phase diagrams of several biopolymers, such as hyaluronic acid [1], pig gastric mucin [2] and three types of starch [3-5]

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References:

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