CHEM 1032 – Spring 2023 - Challenge Question 4

How does temperature affect protein folding?

The folded and unfolded states of a protein exist in equilibrium in aqueous solutions:

$$\text{Protein}_{\text{folded}} \leftrightarrows \text{Protein}_{\text{unfolded}}$$

You are exploring this folding and unfolding process, using a total of 2.75×10^{-3} M protein. You have collected concentration data of the folded and unfolded states at various temperatures.

Temperature (°C)	Unfolded Concentration (M)	Folded Concentration (M)
5	1.9×10^{-3}	6.3×10^{-4}
30	3.4×10^{-4}	2.1×10^{-3}
60	2.2×10^{-3}	5.6×10^{-4}

A. At each temperature, which state is favored? Support your argument with numerical equilibrium constants. *Show your work.*
   Having trouble? Review questions from Chapter 13: 52 and 53.

B. For each temperature, if you started with a sample of all folded protein, is the unfolding process spontaneous? Support your argument with numerical free energy values. *Show your work.*
   Having trouble? Review questions from Chapter 12: 40 and Chapter 13: 89.

C. At each temperature, is the favored process (folding or unfolding) driven by entropy or enthalpy? Justify your answer.
   Having trouble? Review questions from Chapter 12: 45, 49, and 50.

D. Can protein unfolding happen at very low temperatures (below -15 °C). Why or why not? Explain your answer.
   Having trouble? Review material from Unit 1.

Part E on next page…

E. Urea is a small molecule (shown below) that can be used to cause protein unfolding. Using the data below and your answers to parts A through C, does the addition of urea affect the folding and unfolding process at low temperatures (0 °C to 25 °C), moderate temperatures (30 °C to 55 °C) or high temperatures (60 °C and above)? Justify your argument.

Having trouble? Review questions from Chapter 12: 36 and 37.