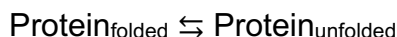


## How does temperature affect protein folding?

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



You are exploring this folding and unfolding process, using a total of  $2.75 \times 10^{-3}$  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	$1.9 \times 10^{-3}$	$6.3 \times 10^{-4}$
30	$3.4 \times 10^{-4}$	$2.1 \times 10^{-3}$
60	$2.2 \times 10^{-3}$	$5.6 \times 10^{-4}$

- 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  $-15^{\circ}\text{C}$ ). 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.*

