1. DNA Practice Problem

DNA is read 5’→3’
Protein is translated N→C

What protein is encoded by the following DNA strand?

DNA: 5’ CTACTCTTTAGCCAT 3’

Solution:
DNA: 5’ CTACTCTTTAGCCAT 3’
Complementary RNA: 5’ AUGGCUAAAGAGUAG 3’
Protein: MAKE

2. Denaturation Practice Problem

Identify the dominant interactions involved in cold denaturation of proteins.

Solution:
Water has a defined crystal lattice at low temperatures, and exposure of internal hydrophobics decreases protein-water bonding and increases the water-water lattice structure, which is exothermic (same direction as ice formation). The predominant force is the hydrophobic effect as hydrogen bonding and ion-ion networks broken during denaturation can be reformed with water.

3. pH/pKa

Useful equations:

\[ \text{pH} = -\log_{10}[H^+] \]

\[ AH \rightleftharpoons A^- + H^+ \]

\[ k_a = \frac{[A^-][H^+]}{[AH]} \]

\[ pK_a = -\log_{10}k_a \]

\[ \text{pH} = pK_a + \log_{10} \frac{[A^-]}{[AH]} \]

What is the protonation state of lysine at pH 2? pH 7? pH 12?
Solution:
pKa of side chain: 10.53
pKa carboxylic acid: 2.18
pKa amino group: 8.95

If pKa > pH: protonated
If pKa < pH: deprotonated

pH 2: lysine protonated, carboxylic acid protonated, amino protonated
pH 7: lysine protonated, carboxylic acid deprotonated, amino protonated
pH 12: lysine deprotonated, carboxylic acid deprotonated, amino deprotonated

pH 7 (physiological pH)