**Exercise II (Nucleic Acids Synthesis and Binding)**

1. Calculate the mass (g) of the human diploid genome using the following information:

   \[
   \text{haploid genome} = 3 \times 10^9 \text{ bp}, \quad \text{G/C content} = 40\%
   \]

   \[
   \begin{align*}
   &\text{2'-deoxyadenosine monophosphate (dAMP)} = 330 \text{ g/mol} \\
   &\text{2'-deoxythymidine monophosphate (dTMP)} = 321 \text{ g/mol} \\
   &\text{2'-deoxyguanosine monophosphate (dGMP)} = 346 \text{ g/mol} \\
   &\text{2'-deoxycytidine monophosphate (dCMP)} = 306 \text{ g/mol}
   \end{align*}
   \]

2. (A) Propose an arrow-pushing mechanism for the following reaction:

   ![Diagram of the reaction](image)

   (B) What is the relevance of this reaction?

   (C) If the phosphoramidite were replaced with an RNA variant, what would the impact be on the rate of the reaction and why? Utilize a drawing of the RNA variant in your response.

3. While \( \text{Mg}^{+2} \) is an important cofactor for the proper function of polymerases and endonucleases, \( \text{Ca}^{+2} \) is usually an inhibitor of these same enzymes. Give two possible reasons why.

4. Targeting duplex DNA can be accomplished by triplex-forming oligonucleotides and Distamycin-like polyamides. Propose a molecule from each family to specifically bind the following DNA sequence: AGAGAGAGAGAAAAA
5. Nucleosides derived from the base analogs Z and Q have been utilized to identify protein-nucleic acid interactions involved in polymerase-mediated DNA synthesis. When these bases are located at the primer terminus, the R668A mutant of Klenow fragment extends the Z-terminated primer at the same rate as the Q-terminated primer. The wild type enzyme preferentially extends Q-terminated primers. Rationalize this observation.

Relevant Literature

