Mechanism problems in preparation for final examination

1. Carboxypeptidase hydrolyzes the C-terminal peptide bonds of peptides. A mechanism for this enzyme is shown below. What are the roles of the $\text{Zn}^{2+}$ ion and Glu-270 in this mechanism?
2. Glycogen phosphorylase is an enzyme that adds phosphate to glycogen to make glucose-1-phosphate (see the picture below). The reaction takes place by nucleophilic attack of a phosphate oxygen onto C-1 of glucose, with concurrent breaking of the C-O bond to yield the final product. Suppose that glycogen phosphorylase uses general acid catalysis to weaken the scissile C-O bond. Draw the structure of an amino acid side chain (in its correct ionization state) that could act as a general acid catalyst in this reaction. Which atom on the phosphate or glycogen might be protonated by the general acid to aid in the reaction? Is water involved in this reaction? Why or why not?
3. Glycogen phosphorylase is an allosteric enzyme, activated by AMP and inhibited by ATP. Sketch out three curves relating \( \frac{v}{V_{\text{max}}} \) and [phosphate], indicating the unaffected glycogen phosphorylase, glycogen phosphorylase in the presence of AMP, and glycogen phosphorylase in the presence of ATP.
4. Suppose that a hypothetical enzyme requires general acid catalysis by two different amino acids, one histidine (pK = 7.0) and aspartic acid (pK = 4.0). Sketch the pH profile for this enzyme; that is, the measured enzyme velocity as a function of pH.