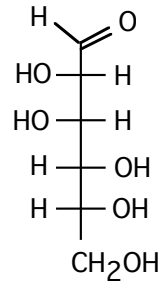
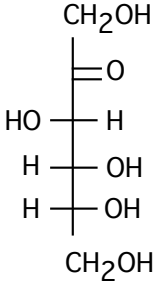
Biochemistry I – Problem Set 7 *Due Nov 11* *Total time required: ~70 min*

1. (14 pts, 25 min) Two monosaccharides are drawn below.
   - i) For each, indicate whether the sugar is an aldose or ketose. (2 pts)
   - ii) Draw the Haworth representation of each sugar that results from cyclization. Draw the α- anomer of (a) and the β- anomer of (b). (4 pts)
   - iii) Name each monosaccharide. (2 pts)
   - iv) Draw and name the C-2 epimer of the sugar shown in (a). (2 pts)
   - v) A common disaccharide is formed when the C-2 epimer (from iv) is linked to the monosaccharide in (b). The O-glycosidic linkage involves both anomeric carbons. Draw the disaccharide resulting from a (1-2) linkage of the α- anomer of the C-2 epimer (from iv) and the β-anomer of the monosaccharide shown in (b). (2 pts)
   - vi) Name the disaccharide. (2 pts)

a)



b)



2. (12 pts, 15 min) Consider the reaction $A \rightarrow B$.
   - i) Write the equation for the standard free energy ($\Delta G°$) and the Gibbs free energy (ΔG) for this reaction. (2 pts)
   - ii) Assuming that the equilibrium constant for this reaction is 1, what are the *relative* concentrations of A and B at equilibrium? (2 pts)
   - iii) Calculate the Gibbs free energy under the following conditions: [A] = 0.01 M, [B] = 0.05 M, T = 300K. (2 pts)
   - iv) Based on your calculation of the Gibbs free energy, what direction will the reaction proceed under the stated conditions, from A to B or from B to A? Justify your answer. (2 pts)
   - v) Energetically unfavorable reactions can be made favorable by altering the ratio of products to reactants. What would the relative concentrations of A and B have to be to make the reaction spontaneous (i.e. $\Delta G < \mathbf{0}$)? (2 pts)
   - vi) Would the change proposed in (v) be an example of direct or indirect coupling? (2 pts)

3. (6 points, 15 min) Triose phosphate isomerase catalyzes the conversion of dihydroxyacetone-P to glyceraldehyde-3-P. The $\Delta G°$ for this reaction is +7.6 kJ/mol. However, the observed free energy change (ΔG) for this reaction in erythrocytes is +2.4 kJ/mol. (Assume that T=300K).

    i) Calculate the ratio of [glyceraldehyde-3-P]/[dihydroxyacetone-P] in erythrocytes. (2 pts)
    ii) If [dihydroxyacetone-P] is 0.2 mM, what is [glyceraldehyde-3-P]? (2 pts)
    iii) List two simple ways by which the conversion of dihyroxyacetone-P to glyceraldehyde-3-P could be made to be more energetically favorable in cells. (2 pts)

4. (6 points, 15 min) Coupling ATP hydrolysis to a thermodynamically unfavorable reaction can cause a significant shift in the equilibrium of the reaction. (Assume that T=300K).

    i) Calculate K_{EQ} for the energetically unfavorable biosynthetic reaction $A \rightarrow B$ when $\Delta G°$= +25 kJ/mol. (3 pts)
    ii) Calculate K_{EQ} for the reaction $A \rightarrow B$ when it is coupled to the hydrolysis of ATP. How does this value compare to that in the uncoupled reaction? (Assume that $\Delta G°$= -30 kJ/mol for ATP hydrolysis). (3 pts)