Making sense of ∆G and ∆G°, when it comes to equilibrium

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Consider the two equations that deal with Delta G (∆G).

Equation 1:

∆G° = – RT ln K

Since K is the equilibrium constant, we *are* at equilibrium, the amounts of products and reactants in the mixture are fixed, and the sign of ∆G**°** can be thought of as a guide to the ratio of the amount of products to the amount of reactants at equilibrium and therefore the *thermodynamic favorability* of the reaction.

If it so happens that products and reactants are equally favored at equilibrium, then ∆G° is zero, **BUT ∆G° is not \*necessarily\* ZERO at equilibrium.**

Equation 2:

∆G = ∆G° + RT ln Q

Since Q is NOT the K, and we are NOT necessarily at the equilibrium position, the sign of ∆G can be thought of as a predictor about which way the reaction (that has reactants and products defined by Q), will go.

If ∆G° is negative at equilibrium, then we will have lots of products at equilibrium, meaning Q needs to be bigger (greater than 1) to approach K. As Q gets larger (i.e., as we get more products), the term ‘RT ln Q’ gets increasingly positive, and eventually adding that term to a negative ∆G°**,**will make ∆G = 0, equilibrium will be established and no further change occurs.

It is possible that Q could already be too large and therefore ∆G is positive. IF so, then the reaction will need to from more reactants, reduce the value of Q, and allow ∆G to reach zero, i.e., allow equilibrium to be established.

If ∆G° is positive at equilibrium, then we will have lots of reactants at equilibrium, meaning Q needs to be smaller (less than 1) to approach K. As Q gets smaller (i.e., as we get more reactants), the term ‘RT ln Q’ gets increasingly negative, and eventually adding that term to a positive ∆G°**,**will make ∆G = 0, equilibrium will be established and no further change occurs.

It is possible that Q could already be too small and therefore ∆G is negative, IF so, then the reaction will need more products, increase the value of Q, and allow ∆G to reach zero, i.e., allow equilibrium to be established.

In short, it is ∆G (NOT ∆G°) that will be zero at equilibrium and the sign of *it* (generated by the combination of ∆G° and RT ln Q in Equation #2), will define which way the reaction proceeds.

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