impossible for enzymes. Therefore, for biochemical reactions, unlike the physical chemists, we determine such reactions standard free energy change at pH 7.0. This will change equilibrium position due to mass action, so we designate such standard free energy changes, where all products and reactants are 1.0 M (or with gases 1 atm.) except H+ concentrations, which is pH 7.0, with a ΔG°.

COUPLING OF REACTIONS

The standard free energy changes of chemical reactions are additive for a reaction: A ---> B ---> C

ΔG° of overall reaction

ΔG° B ---> C.

If

ΔG° A ---> B = +1363 Cal
ΔG° B ---> C = -4089 Cal

ΔG° A ---> C = -2726 Cal

This principle is often used to make reactions go which would not otherwise go. Overall reaction is now exergonic, because we have added the "acid-activation" step. Utilization of hi-energy phosphate bond energy in coupled reaction to "pull" the overall reaction. "Acid activation" concept was developed by Fritz Lipmann, who won Nobel prize for the work.

Coupling is one of the most important uses of ATP in a living cell. Provides energy to make reactions go.

OXIDATION-REDUCTION REACTIONS

To calculate free energy changes during oxidation-reduction reactions, we must be able to measure the relative tendencies of compounds to give up their electrons and themselves become oxidized. To do this we need a standard. This is the hydrogen electrode, where the following half reaction occurs: H+ + 1e- ---> 1/2 H2, written as a reduction. This half-reaction is arbitrarily assigned the value zero and all others are related to it, as if they were coupled reactions to it. However, since H+ is utilized in the reaction, we should express the reaction at pH 7.0, and not pH 0.0. This changes the value to -0.420 volts, as measured by a potentiometer in volts.

Biologically there are many oxidation-reduction reactions we may be capable of studying. These reactions may be arranged on a scale with the E°, or reduction potential as related to the hydrogen electrode at pH 7.0. All half-reactions are written as reductions. The values reported are the actual voltages potentials which would develop if these half-reactions were coupled to the hydrogen electrode at pH 7.0 and assigning it a
Figure 18

Transaldolase