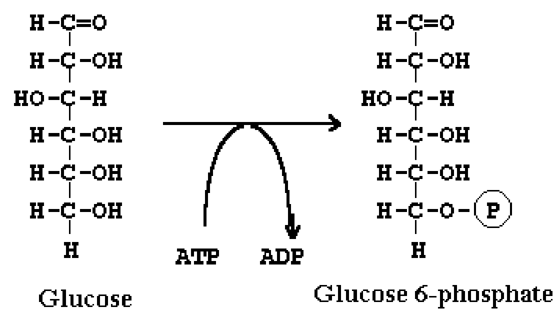
AP Biology
Notes: Glycolysis

Glycolysis = (glyco = sweet, sugar; lysis = to spilt); catabolic pathway during which six carbon glucose is split into two three-carbon sugars, which are the oxidized and rearranged by a step-wise process that produces two pyruvate molecules.

* Each reaction is catalyzed by specific enzymes dissolved in the cytosol
*No CO_2 is released as glucose is oxidized to pyruvate; all carbon in glucose can be accounted for in the two molecules of pyruvate
*Occurs whether or not oxygen is present

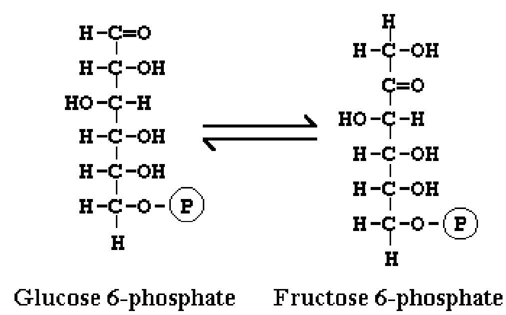
The reactions of glycolysis occur in two phases.
Activation stage
Energy harvesting stage



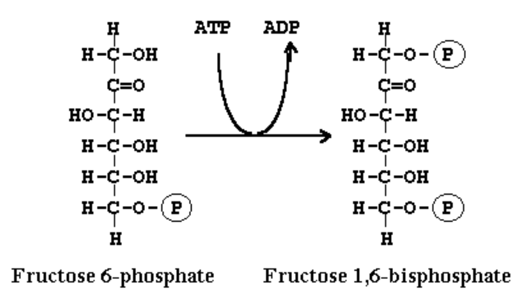
Step 1: Glucose enters the cell, and carbon six is phosphorylated.
This is an ATP-coupled reaction:

*Is catalyzed by *hexokinase*
*Requires an initial investment of ATP
*Makes glucose more chemically reactive
* Produces glucose-6-phosphate
* traps the sugar in the cell

Step 2: An *isomerase* catalyzes the rearrangement of glucose-6-phospahte to its isomer, furctose-6-phospahte.



Step 3: Carbon one of furctose-6-phospahte is phophorylated.

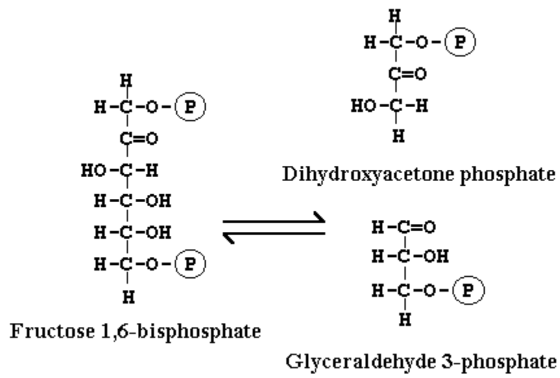


This reaction:

*Requires an investment of another ATP
*Is catalyzed by *phophofuctokinase*, and allosteric enzyme that controls the rate of glycolysis, this step commits the carbon skeleton to glycolysis, a catabolic process as opposed to being used to synthesize glycogen, an anabolic process.

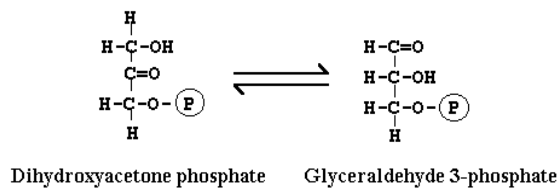
Step 4: *Aldolase* cleaves the six-carbon sugar into two isomeric three-carbon sugars.

* This is the reaction for which glycolysis is named
*For each glucose molecule that begins glycolysis, there is two product molecules for this and each succeeding step.



Step 5: An isomerase catalyzes the reversible conversion between the two three-carbon sugars. This reaction:

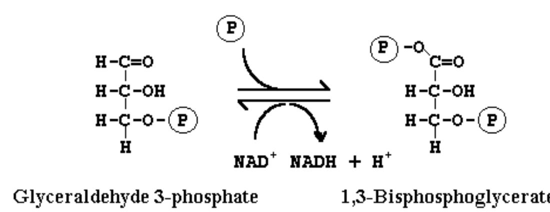
*Never reaches equilibrium because only one isomer, *glyceraldehyde phospahte,* is used in the next step of glycolyss.
*Is thus pulled towards the direction of glyceradehyde phosphate, which is removed as fast as it forms.
*Results in the net effect that, for each glucose molecule, two molecules of glyceraldehdyed phosphate progress through glycolysis.
*Energy-yielding phase



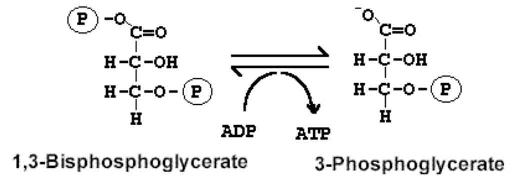
Step 6: An enzyme catalyzes two sequential reactions:

1. Glycerhaldehyde phosphate is oxidized and NAD^+ is reduce to NADH + H^+.
   *This reaction is very exergonic and is coupled to the endergonic phosphorylation phase (ΔG = -10.3 kcal/mol)
   * For every glucose molecule 2 NADH are produced

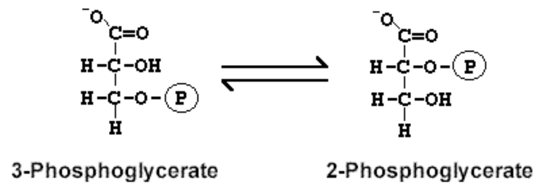
2. Glyceraldehyde phosphate is phosphorylated on carbon one.
   *The phosphate source is inorganic phosphate, which is always present in the cytosol
   *The new phosphate bound is a high energy bond with even more potential to transfer a phosphate group than ATP.



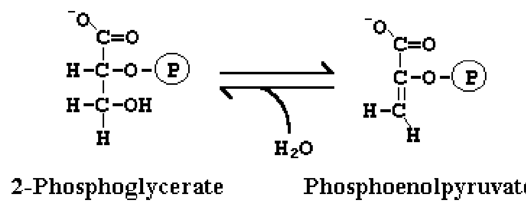
Step 7: ATP is produced by substrate-level phosphorylation
* Is a very exergonic reaction, the phosphate group with the high energy bond is transferred from 1,3-diphosphoglycerate to ADP
*For each glucose molecule, two ATP molecules are produced



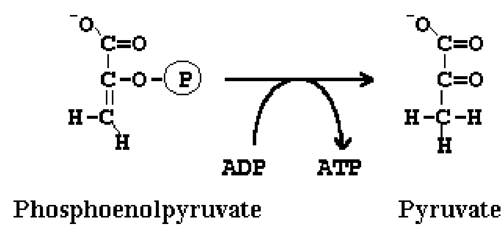
Step 8: In preparation for the next reaction a phosphate group on carbon three is enzymatically transferred to carbon two.



Step 9: Enzymatic removal of a water molecule:
*Creates a double bond between carbons one and two of the substrate
*Rearranges the substrate's electrons, which transforms the remaining phosphate bond into an unstable bond.



Step 10: ATP is produced by substrate-level phosphorylation
*Is a highly exergonic reaction, a phosphate group is transferred from PEP to ADP
*For each glucose molecule, this step produces two ATP.



Summary equation for glycolysis:

Glucose has been oxidized into tow pyruvate molecules.