# Glycolysis: The Energy Payoff

- **Review:** The energy investment phase of **glycolysis** involves the investment of two **ATP** molecules and results in the formation of two molecules of glyceraldehyde phosphate.
- The energy payoff phase of glycolysis consists of five additional steps and results in the formation of four **ATP**, two **NADH + H$^+$**, and two **pyruvate** molecules.

**Substrate level phosphorylation** is the process by which ATP is produced from the transfer of a phosphate group from a substrate molecule in a metabolic pathway.

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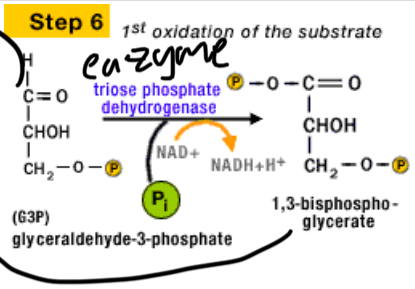
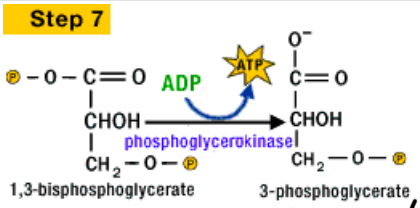
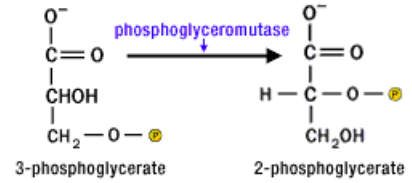
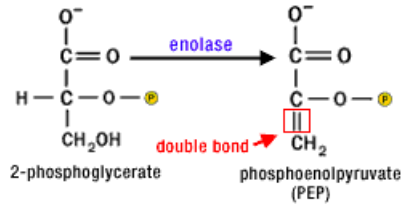
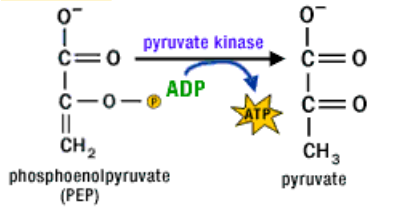
| **Step 6**   | **Step 6:** Glyceraldehyde phosphate is oxidized (NAD+ is reduced) and phosphorylated by the enzyme triose phosphate dehydrogenase to produce 1, 3-bisphosphoglycerate. Two molecules of **NADH + H$^+$** are produced.<br><br>This is an example of a **coupled reaction**. The highly exergonic redox reaction fueled the endergonic formation of the phosphate bond. |
| **Step 7**   | **Step 7:** A phosphate group is removed from each 1, 3-bisphosphoglycerate to make two **ATP** and 3-phosphoglycerate. This reaction is mediated by the enzyme phospho-glycerokinase.<br><br>This reaction is an example of **substrate level phosphorylation**. A phosphate group was removed from a substrate molecule and added to ADP to make ATP. |
| **Step 8**   | **Step 8:** The remaining phosphate group is transferred to the middle carbon by the enzyme phosphoglyceromutase. This reaction will energize the molecule and make it less stable. 2-phosphoglycerate results. |
| **Step 9**   | **Step 9:** A water molecule is removed and a double bond is added to both 2-phosphoglycerate molecules to produce two phosphoenolpyruvate (also known as PEP) molecules. |
| **Step 10**   | **Step 10:** Both PEP molecules are dephosphorylated by pyruvate kinase to produce two **pyruvates** and two ATP. |