Adenylate Kinase Reaction

The phosphagen system is referred to as a system because it has more than one reaction. It is tempting to view the creatine kinase reaction as the most important reaction of this system, simply based on the relatively large store of intramuscular creatine phosphate. While the creatine kinase reaction is important, as you now know, the transfer of phosphate groups throughout the cytosol, as well as the regulation of carbohydrate catabolism could not exist without the adenylate kinase reaction.

The **adenylate kinase reaction** is named after the **adenosine** chemical group as illustrated in Figure 1. For this reaction, the adenylate molecules of interest are ADP and ATP (Equation 1 and Figure 2).

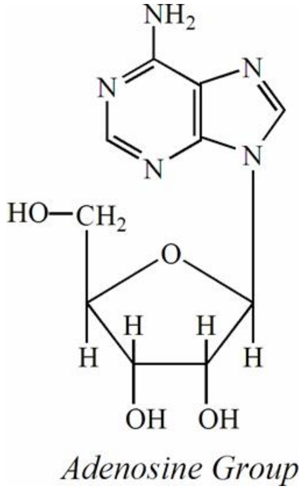

Figure 1. The adenosine chemical group.

$$ADP + ADP \overset{\text{adenylate kinase}}{\leftrightarrow} ATP + AMP \qquad \text{Equation 1}$$

For the adenylate kinase reaction to proceed there needs to be meaningful increases in muscle ADP, as this is another example of an equilibrium reaction. Muscle ATP is kept fairly constant during low to moderately intense exercise at 8.4 mmol/kg wet wt. The muscle ADP concentration is very low at approximately 0.001 mmol/kg wet wt, and AMP is not detectable in resting muscle.

Given this information, the adenylate kinase reaction is only operable during moderate to more intense exercise, when the rate of ATP demand exceeds the ability of the mitochondria to sustain both ATP supply and prevent even small increases in muscle ADP. The adenylate kinase reaction has a low capacity, in that it can only contribute about 10 mmol ATP/kg wet wt during the most intense and fatiguing exercise. As such, one could question the relevance of this reaction to net ATP balance in contracting muscle.

However, the importance of the adenylate kinase reaction is not really in the ATP regeneration, but in the **AMP** production (Figure 2). AMP is an **allosteric activator** of **phosphorylase** (glycogen breakdown or glycogenolysis) and **phosphofrucktokinase** (PFK, phase 1 of glycolysis). Thus, the adenylate kinase reaction operates to provide a small amount of additional ATP, keep muscle ADP concentrations low which favors a sustained high free energy release during ATP hydrolysis, and produces an important enzyme activator (AMP) to fuel (glycogenolysis) and activate (PFK) glycolysis. As such, <u>the adenylate kinase reaction is the link between the phosphagen and glycolytic energy systems</u>.

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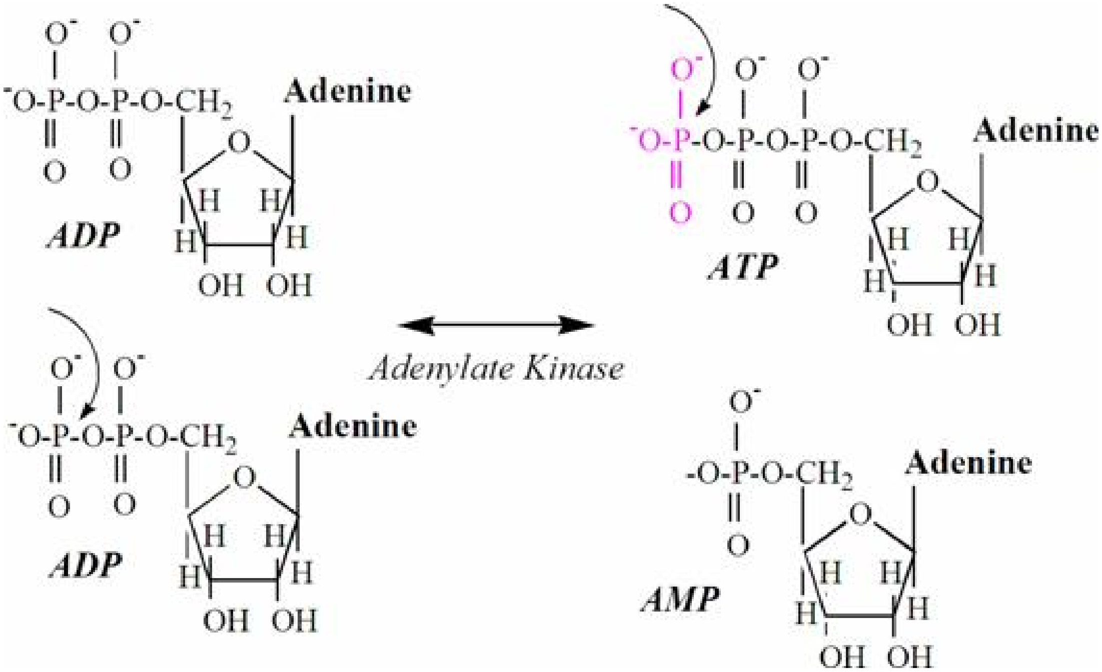

Figure 2. The chemical structures of the substrates and products of the adenylate kinase reaction.

Glossary Words

adenylate kinase reaction is the reaction that converts two ADP molecules to ATP and AMP during times of increased cellular ATP demand.

adenosine refers to the functional group consisting of an adenine base and a ribose sugar, which forms the main structure of the adenylate molecules ATP and ADP.

AMP is the abbreviation for adenosine monophosphate, which is a product of the adenylate kinase reaction in the direction of ATP regeneration, as well as being an allosteric activator of phosphorylase and phosphofructokinase (PFK).

allosteric activator is a molecule that when ionically bound to an enzyme causes increased catalytic activity of the enzyme.

phosphorylase is the main enzyme (1 of 3) responsible for the breakdown of glycogen in the process of glycogenolysis.