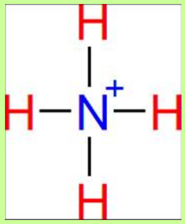
AMP Deaminase Reaction

The AMP deaminase reaction is not a major energy contributor during muscle catabolism. Thus, I am not requiring that you learn this reaction to support your understanding of ATP provision to contracting muscle. Rather, this reaction completes the immediate reactions concerning the metabolism of AMP, and more importantly, is a major (not the only!) source of ammonia (NH_4^+) during intense exercise. If you have performed intense exercise training, or been associated with athletes who do, you will relate to the strong smell of ammonia from sweat. Such ammonia comes from the adenylate kinase reaction, as well as from amino acid oxidation and subsequent deamination. Ammonia circulates from muscle, and as sweat is a filtrate of blood plasma, if ammonia is in the blood, it will be excreted in sweat. In short, smell the shirt or sweater of an athlete after a workout, and if you do not smell ammonia, you know they didn't really work out that hard!!!!!



The **AMP deaminase reaction** is presented in Equation 1 and Figure 1.

$$AMP + H_2O + H^+ \overset{AMP\ deaminase}{\leftrightarrow} IMP + NH_4$$

I know what you are thinking. If AMP is such an important activator of key allosteric enzymes, then why have a reaction that removes it? This question is all the more meaningful when you realize that the ammonium ion (NH_4^+) product of this reaction is toxic to muscle and the body, and must be processed in the liver to urea and then excreted by the kidney.

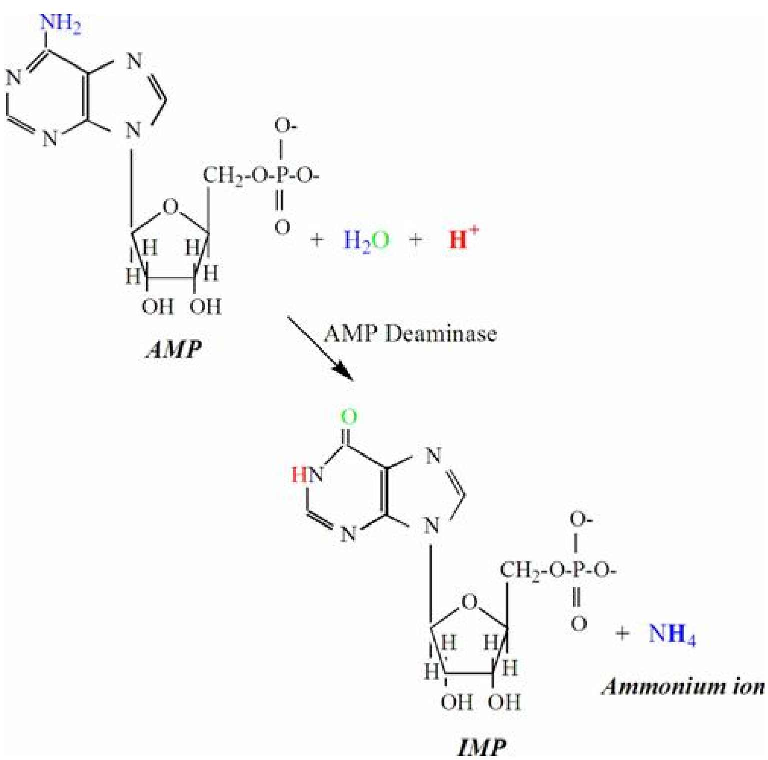


Figure 1. The chemical structures of the substrates and products of the AMP deaminase reaction.

While the detailed answer is complex, let me start by telling you that the answer lies in bioenergetic principles. Remember that if ATP concentrations fall, and adenylate products increased, then the free energy release from ATP and ADP reactions, such as the ATPase and adenylate kinase reactions, would decrease. Thus, it is advantageous for contracting muscle to keep a relatively stable ATP, and equally importantly, a relatively stable relationship between ATP and each of ADP and

AMP. Leaving AMP to accumulate would seriously lower what is called the phosphate transfer potential, or **phosphorylation potential**, of reactions involving ADP and ATP. Thus, keeping AMP relatively low in concentration is a means to prevent what could amount to severe decreases in the free energy release of ATP hydrolysis.

Maintaining a small increase in AMP is enough to still have AMP function as an allosteric activator, as only small increases in AMP (remember cell AMP in resting muscle is practically not detectable) are needed to induce allosteric enzyme activation.

The AMP deaminase enzyme is activated during acidosis, and as such is really only operative within the phosphagen system during intense exercise.

Glossary Words

AMP deaminase reaction converts AMP, water and a H^+ to IMP and ammonia (NH_4^+).

phosphorylation potential the relative proportion of ATP to the product of ATP, ADP and AMP. The closer this value is to 1.0, the greater the free energy release from ATP hydrolysis.