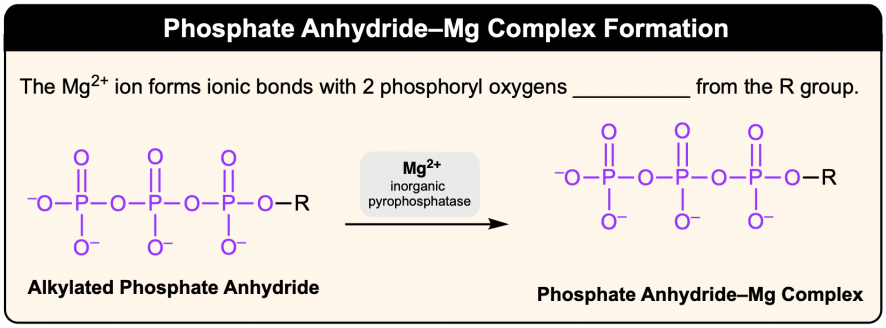
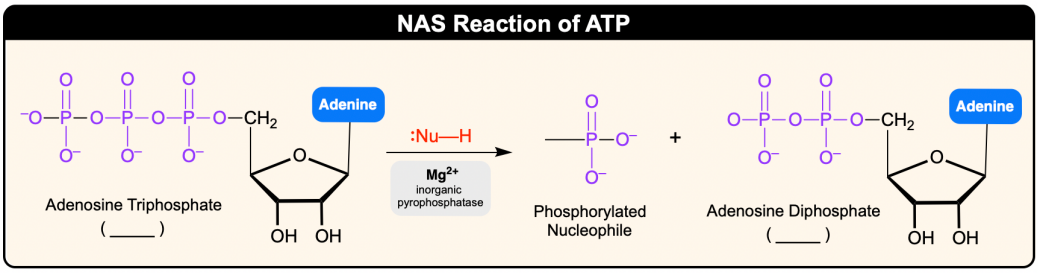
CONCEPT: CHEMICAL REACTIONS OF PHOSPHATE ANHYDRIDES

- The _____ negative charges of a phosphate anhydride make its P atoms resistant to nucleophilic attack.
  - □ _____ ion and a class of enzymes called _____ pyrophosphat_____ reduces the overall negative charges.
  - □ **Phosphate Anhydride–Mg Complex**: The ionic bonds that form between phosphoryl _____ atoms and _____.



Enzyme–Catalyzed NAS Mechanism

- After Mg complex formation, phosphate anhydrides react with nucleophiles at __-phosphate position via NAS mechanism.



CONCEPT: CHEMICAL REACTIONS OF PHOSPHATE ANHYDRIDES

EXAMPLE: Provide the mechanism for the enzyme-catalyzed reaction between ATP and a nucleophile.

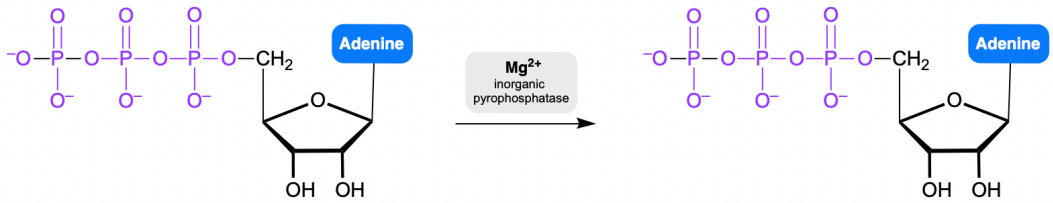
Step 0 — Ionic Bond Formation

Step 1 — Nucleophilic Attack

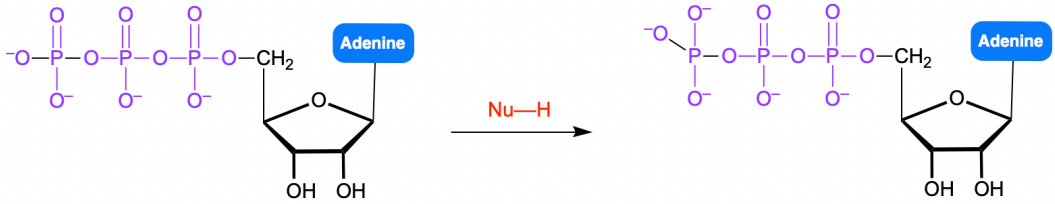
Step 2 — Proton Transfer

Step 3 — Leaving Group

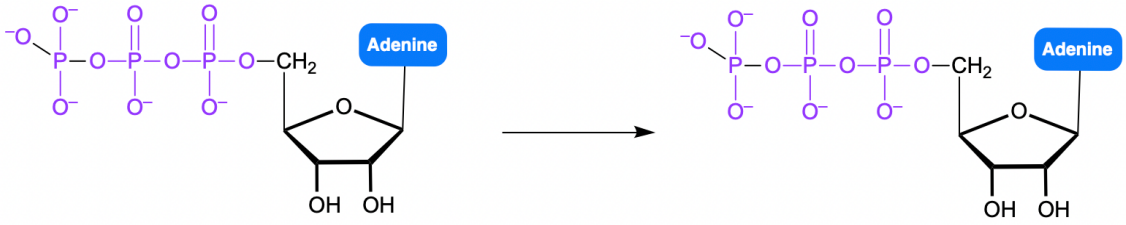
STEP 0: The _____ ion forms an ionic bond with ____ of the negatively charged oxygens of phosphate anhydride.



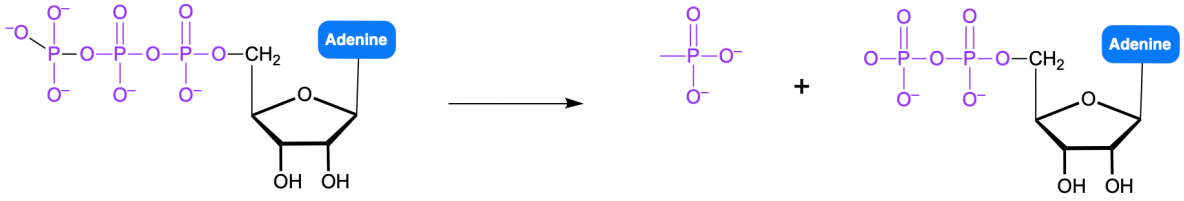
STEP 1: Nucleophile attacks the phosphoryl ____.



STEP 2: A proton is transferred from the ____ charged nucleophile to the O between the ____ or ____ P atoms.



STEP 3: An ____ atom pushes its lone pair to kick out ADP as the _____ ion is also released.



CONCEPT: CHEMICAL REACTIONS OF PHOSPHATE ANHYDRIDES

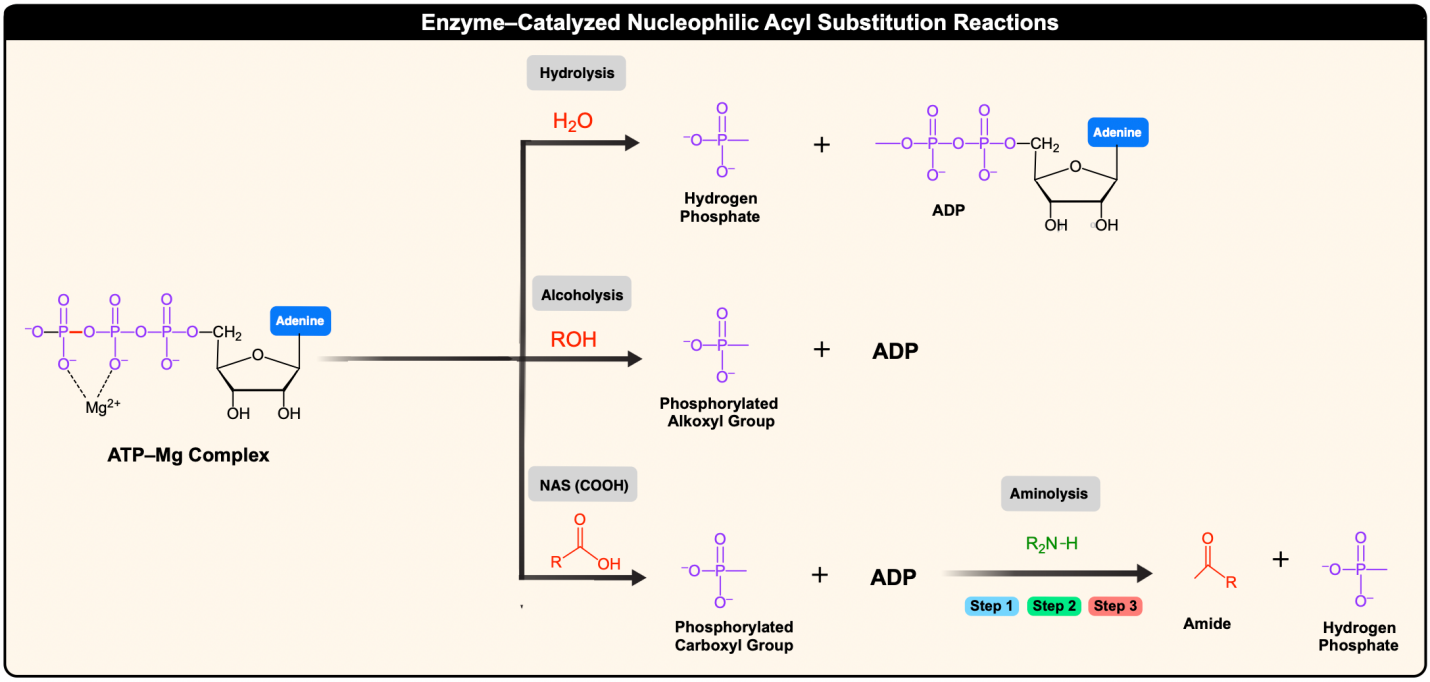
Reactions of ATP

- Upon Mg complex formation, ATP can react with a nucleophile at the ____-phosphate position.

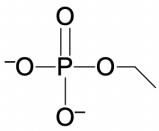
1) **Hydrolysis:** Reaction of ATP with _____.

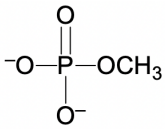
2) **Alcoholysis:** Reaction of ATP with _____.

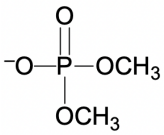
3) **NAS of COOH:** Reaction of ATP with _____.

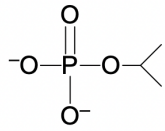


EXAMPLE: What products are formed when ethanol reacts with ATP in the presence of Mg^{2+} and its necessary pyrophosphatases?

a)  + **ADP**

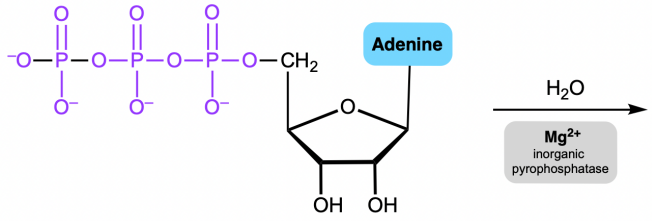
b)  + **ADP**

c)  + **ADP**

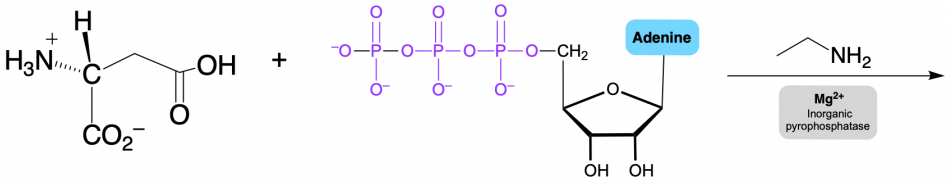
d)  + **ADP**

CONCEPT: CHEMICAL REACTIONS OF PHOSPHATE ANHYDRIDES

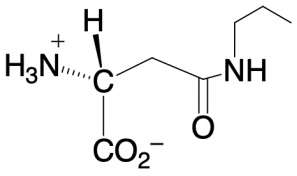
PRACTICE: Write a mechanism for enzyme-catalyzed hydrolysis of the ATP molecule.



PRACTICE: Provide final product from the reaction of aspartic acid, ATP and ethylamine.



a)



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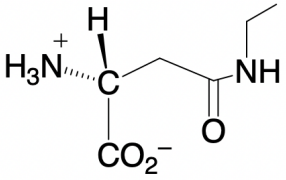
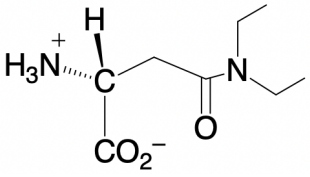


c)



d)