Programme: B.Sc. Microbiology

Subject: Microbiology

Paper Code: MID - 102

Paper Title: Microbial Physiology

Unit: 01 Bioenergetics and Electron Transport Chain

Module Name: Energy Rich Compounds- Part I

Module No: 03

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Notes

Energy Rich Compounds

On hydrolysis, compounds yield energy and they can be classified as high energy compounds or Low- energy compounds based on the amount of energy they release.

Energy rich compounds: Substances which possess sufficient free energy to liberate **at least 7** Cal/mol at pH 7.0

Low- energy compounds: Compounds which liberate **less than 7** Cal/mol (lower than ATP hydrolysis to ADP + Pi)

All the high energy compounds when hydrolyzed liberate **more energy than that of ATP.**

Most of the high energy compounds contain **phosphate group** (except acetyl CoA) hence they are also called **high energy phosphates.**

The high energy compounds possess ***Acid anhydride bonds*** (mostly phosphoanhydride bonds) formed by the **condensation of two acidic groups** or related compounds.

These bonds are referred to as high energy bonds, since the free energy is liberated when these bonds are hydrolyzed.

These bonds are notated by the symbol '~' [squiggle] – invented by Fritz Albert Lipmann. Eg. ATP is written as **AMP ~ P ~ P**

Classification of high energy compounds

i. Pyrophosphate bond

The energy bonds in pyrophosphates are acid anhydride bonds. These bonds are formed by the condensation of acid groups [mainly phosphoric acid] or its derivatives.

Eg. is ATP. It has two high energy diphosphate bonds –phosphoanhydride bonds

ii. Enol phosphate bond

The bond present here is enolphosphate bond. It is formed when phosphate group attaches to a hydroxyl group which is bounded to a carbon atom having double bond ***Eg***. Phosphoenolpyruvate

iii. Acyl phosphates

The high energy bond in this compound is formed by the reaction between carboxylic acid group and phosphate group. ***Eg***. 1,3-bisphosphoglycerate.

iv. Thiol phosphate

Here high energy phosphate bond is absent. Instead high energy thioester bond is present.

Thioester bond results from the reaction between thiol and carboxylic acid group.

Eg. Acetyl CoA

v. Guanido phosphates bond/ phophagens.

It is formed by the attachment of phosphate group to guanidine group. ***Eg***.
Phosphocreatine

ATP

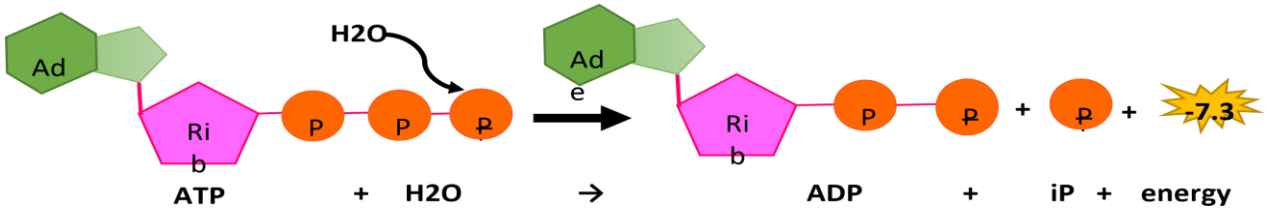
Most important high energy compound in the living cell.

It contains an adenine group, a ribose sugar and a triphosphate.

ATP is considered as an high energy compound because of the presence of two phosphoanhydride bonds.

Hydrolysis of the terminal phosphate group yields high negative free energy i.e. -7.3 cal / mol It transfers phophoryl groups from high energy compounds to less energetic

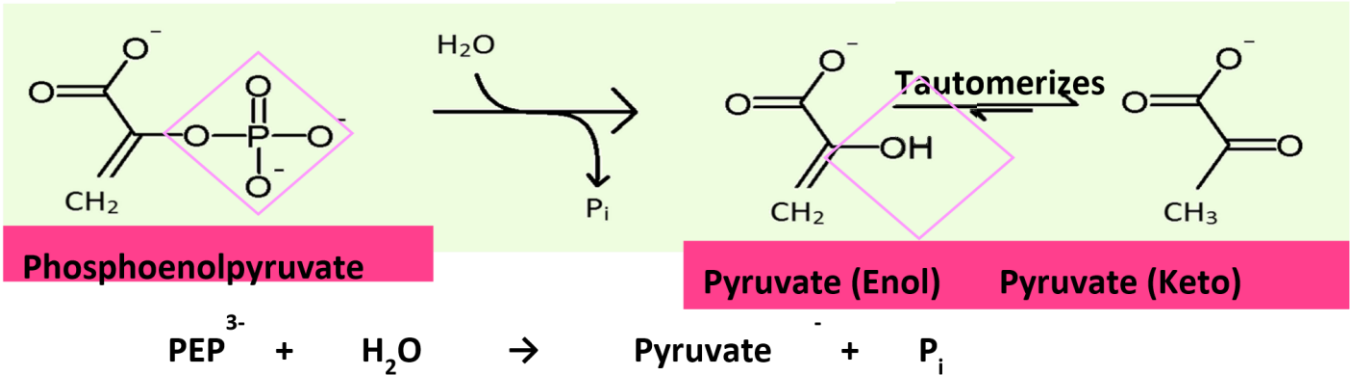
compounds.



Phosphoenolpyruvate

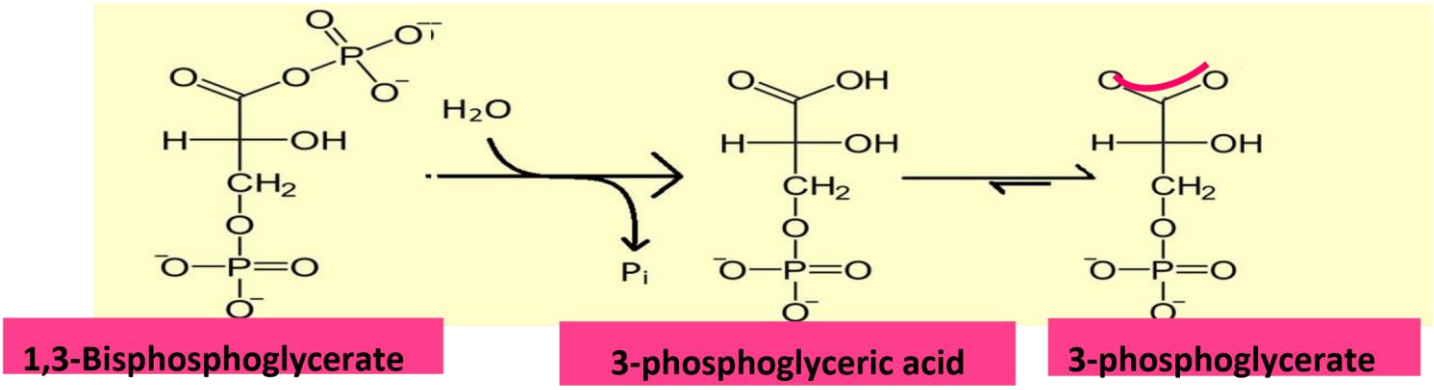
Intermediate in glycolysis and gluconeogenesis

Phosphate ester bond undergoes hydrolysis and yields the enol form of pyruvate, which immediately tautomerizes to the more stable keto form. **G'°= -14.8 Cal/mol**



1,3-bisphosphoglycerate

On hydrolysis, 1,3-BPG, gives 3-phosphoglyceric acid, which immediately loses a proton to give the carboxylate ion, 3-phosphoglycerate, which has two equally probable resonance forms. Removal of the direct product & formation of the resonance-stabilized ion favor the forward reaction. **G'°= -11.8 Cal/mol**



$$1,3\text{-Bisphosphoglycerate}^{4-} + H_2O \rightarrow 3\text{-phosphoglycerate}3^{-} + Pi^{2-} + H^{+}$$