Macroergic compounds

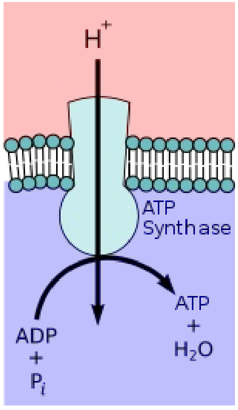
ATP

ATP is a major and versatile macroergic compound. It partly ensures the storage and especially the transfer of free energy (G) in the cell. In addition to ATP, there are also other macroergic compounds that are capable of releasing a larger amount of energy by splitting. ATP is used the most. This is due to the relative stability of the anhydride bond, which resists spontaneous hydrolysis, unlike other anhydrides, and is cleaved only in the presence of enzymes.

To regenerate ATP, it is then possible to use substances with more negative free energy values, e.g. phosphoenolpyruvate, creatine phosphate, 1,3-bisphosphoglycerate.

Generation of ATP

ATP can be produced in a cell by:



ATP Synthase

- **Phosphorylation at the substrate level.** This is an energy coupling exergonic reaction with the synthesis of ATP from ADP and P_i. Three reactions are most often described: two are part of **glycolysis** (conversion of phosphoenolpyruvate to pyruvate and 1,3-bisphosphoglycerate to 3-phosphoglycerate), one is part of the **Krebs cycle** (conversion of succinyl-CoA to succinate).
- **Aerobic phosphorylation and the respiratory chain.**

For more information see Respiratory chain and ATP formation .

Energy release from ATP

ATP hydrolysis takes place in several steps:

1. ATP → ADP + P_i (ΔG = −30.5 kJ/mol);

   There is one more macroergic bond in ADP that can be used. However, since the use of ADP instead of ATP is problematic due to the substrate specificity of the enzymes, the reaction catalyzed by ``adenylate kinase *usually takes place:*

2. 2 ADP → ATP + AMP

   and the generated ATP is used.

Diphosphate (pyrophosphate, PP_i) is directly released from ATP by the action of some enzymes:

ATP → AMP + PP_i (ΔG = −45.6 kJ/mol).

PP_i can be further cleaved by the enzyme ``diphosphatase *(pyrophosphatase) to release energy.*

Other macroergic compounds

- **Other nucleoside triphosphates** are less versatile and are used for specific purposes. E.g. UTP serves to activate carbohydrates for their entry into metabolic pathways.
- **Enol phosphates** contain a − OH group, which is esterically bound to the phosphate. The most important representative, phosphoenolpyruvate (PEP), is a macroergic compound with the highest energy potential ΔG (up to − 61.9 kJ/mol). Therefore, the reaction of converting PEP to pyruvate is also an irreversible reaction of glycolysis.
- **Acyl phosphates** contain an anhydride bond −COOH with phosphate. These include carbamoyl phosphate (used in the synthesis of urea) or 1,3-bisphosphoglycerate (an intermediate of glycolysis).
- Other macroergic compounds include **guanidine phosphates'** (eg creatine phosphate) or **thioesters and thioethers** (HS-CoA derivatives, SAM). Sometimes we can come across the term *low-energy phosphates.* Low-energy phosphates include, for example, glucose-6-phosphate and release less energy, between 9 and 20 kJ/mol.

Reference

- ws: Makroergní sloučeniny