

ENERGY RICH COMPOUNDS

- Certain compounds in the biological system on hydrolysis yield energy.
- High energy compounds or energy rich compounds are those substances which possess sufficient free energy to liberate at least 7 Cal/mol at pH 7.0
- The compounds that liberate less than 7 Cal/mol are known as low energy compounds.
- Most of the high energy compounds contain phosphate group and hence they are known as the high energy phosphate compounds

Compounds	ΔG^0 (Cal/mol)
High energy phosphate	
Phosphoenol pyruvate	-14.8
Carbamoyl phosphate	-12.3
Cyclic AMP	-12.0
1,3-Bisphosphoglycerate	-11.8
Phosphocreatine	-10.3
Acetyl phosphate	-10.3
S-Adenosylmethionine	-10.0
Pyrophosphate	-8.0
AcetylCoA	-7.7
ATP \longrightarrow ADP+Pi	-7.3
Low energy phosphates	
ADP \longrightarrow AMP + Pi	-6.6
Glucose-1-phosphate	-5.0
Fructose-6-phosphate	-3.8
Glucose-6-phosphate	-3.3
Glycerol-3-phosphate	-2.2

CLASSIFICATION OF HIGH ENERGY COMPOUNDS

- There are at least 5 groups of high energy compounds
 1. Pyrophosphates
 2. Acylphosphates
 3. Enol phosphates
 4. Thioesters
 5. Phosphagens

TABLE 11.2 High-energy compounds

<i>Class</i>	<i>Bond</i>	<i>Example(s)</i>
Pyrophosphates	$-\text{C}-\text{P}-\text{P}$	ATP, pyrophosphate
Acyl phosphates	$-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}\sim\text{P}$	1,3-Bisphosphoglycerate, carbamoyl phosphate, acetyl phosphate
Enol phosphates	$-\overset{\text{CH}}{\parallel}{\text{C}}-\text{O}\sim\text{P}$	Phosphoenol pyruvate
Thiol esters (thioesters)	$-\overset{\text{C}}{\parallel}{\text{C}}-\text{O}\sim\text{S}-$	Acetyl CoA, acyl CoA
Guanidino phosphates (Phosphagens)	$-\overset{ }{\text{N}}\sim\text{P}$	Phosphocreatine, phosphoarginine

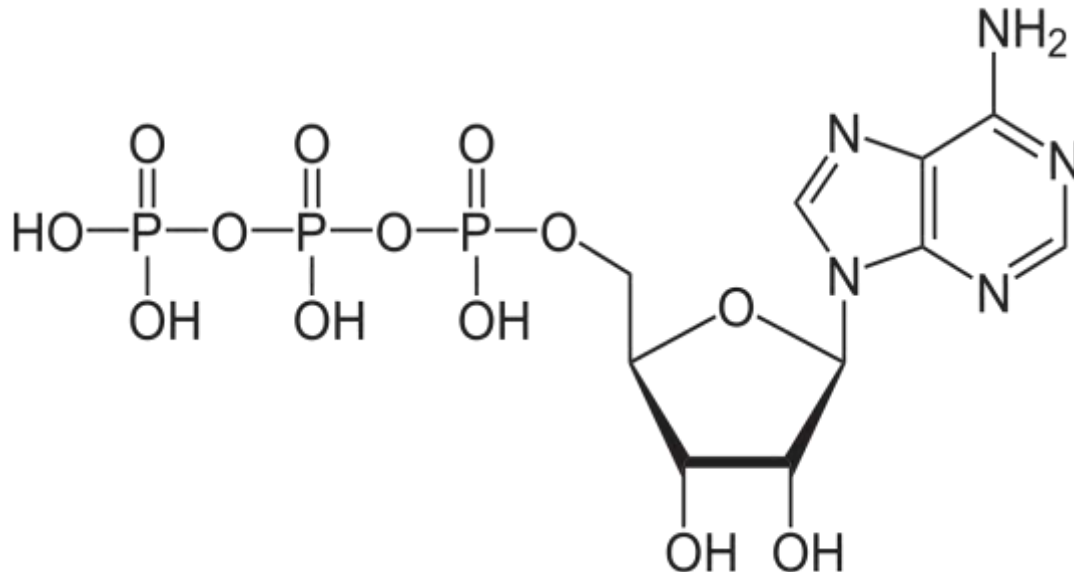
HIGH ENERGY BONDS

- The high energy compounds possess acid anhydride bonds (mostly phosphoanhydride bonds) which are formed by the condensation of two acidic groups or related compounds.
- These bonds are called high energy bonds since the free energy is liberated when these bonds are hydrolysed.
- The symbol ~ is used to represent high energy bonds
- Eg: ATP ~ P ~ P

AT

P

- ATP is the most important high energy compound in the living cells.
- It consists of an adenine, a ribose & a triphosphate moiety.
- ATP is a high-energy compound due to the presence of two phosphoanhydride bonds in the triphosphate unit.
- ATP serves as the **energy currency of the cell.**



BIOLOGICAL SIGNIFICANCE:

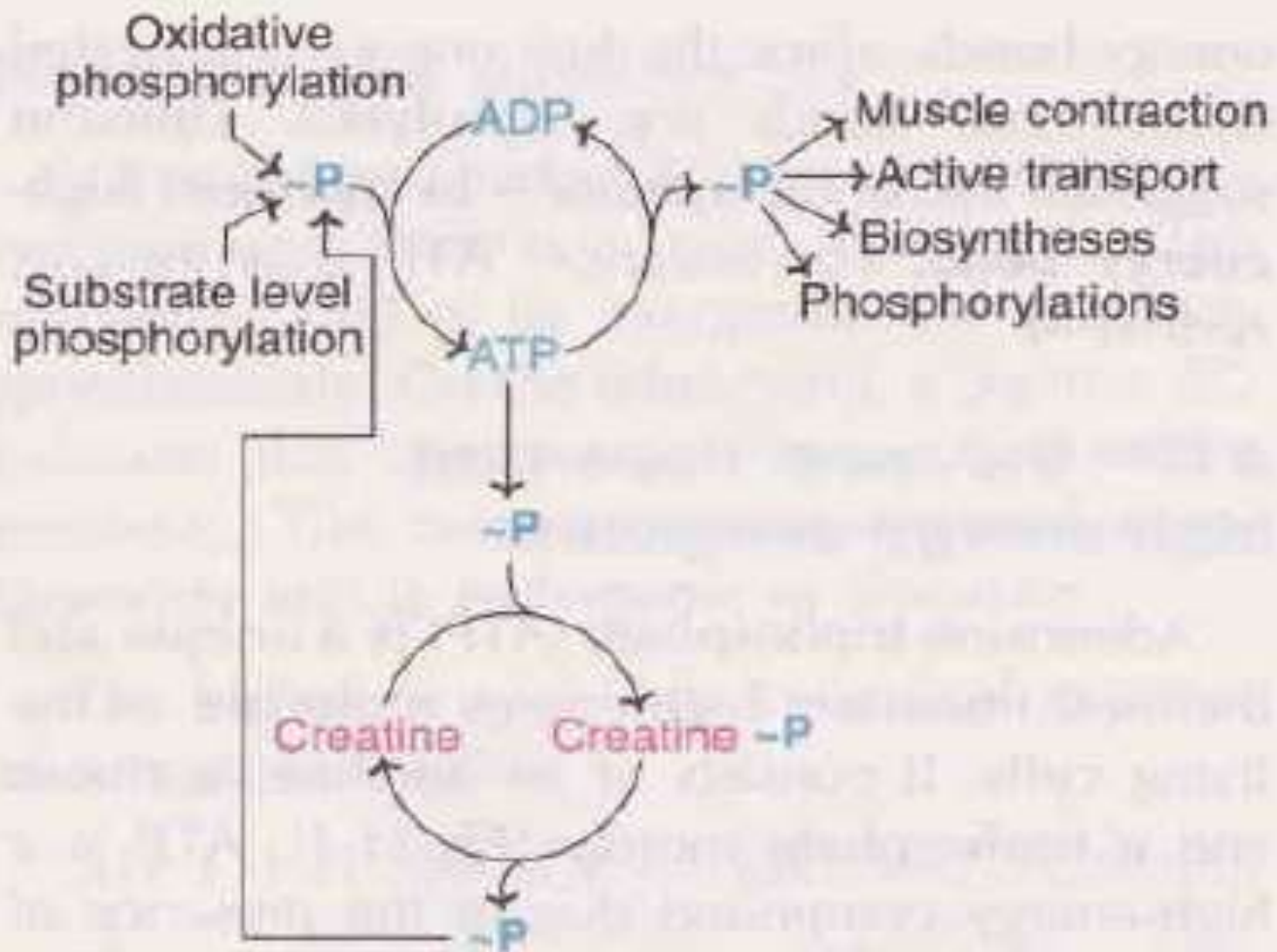
- The hydrolysis of ATP is associated with the release of large amount of energy.



- The energy liberated is used for various processes like muscle contraction, active transport etc.
- ATP can act as a donor of high-energy phosphate to low-energy compounds, to make them energy rich.
- ADP can accept high-energy phosphate from the compounds possessing higher free energy content to form ATP.
- ATP is constantly being utilized and regenerated.
- This is represented by ATP-ADP cycle, the fundamental basis of energy exchange reactions in living system.
- ATP acts as an energy link between the catabolism (degradation of molecules) and anabolism(synthesis) in the biological system.

SYNTHESIS OF ATP:

- ATP can be synthesized in two ways:
 1. Oxidative phosphorylation :
 - This is the major source of ATP in aerobic organisms
 - It is linked with the mitochondrial electron transport chain .
 2. Substrate level phosphorylation :
 - ATP may be directly synthesized during substrate oxidation in the metabolism.
 - The high-energy compounds such as phospho enolpyruvate and 1,3-bisphosphoglycerate and succinyl CoA can transfer high-energy phosphate to ultimately produce ATP.



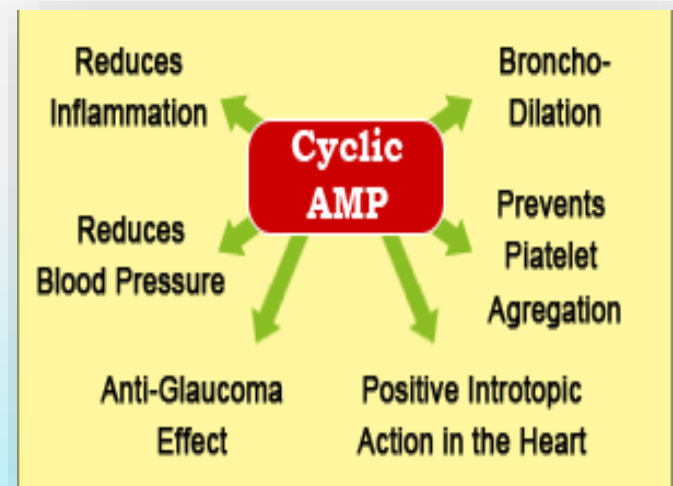
CYCLIC AMP

- cAMP is a cyclic nucleotide.
- Chemically it is 3'5' adenosine monophosphate.
- It is synthesized in tissues from ATP under the influence of adenylyl cyclase in presence of Mg ions.
- cAMP decomposition into AMP is catalyzed by the enzyme phosphodiesterase.
- cAMP is a second messenger.
- It is used for intracellular signal transduction, such as transferring the effects of hormones like glucagon and adrenaline, which cannot pass through the cell membrane.

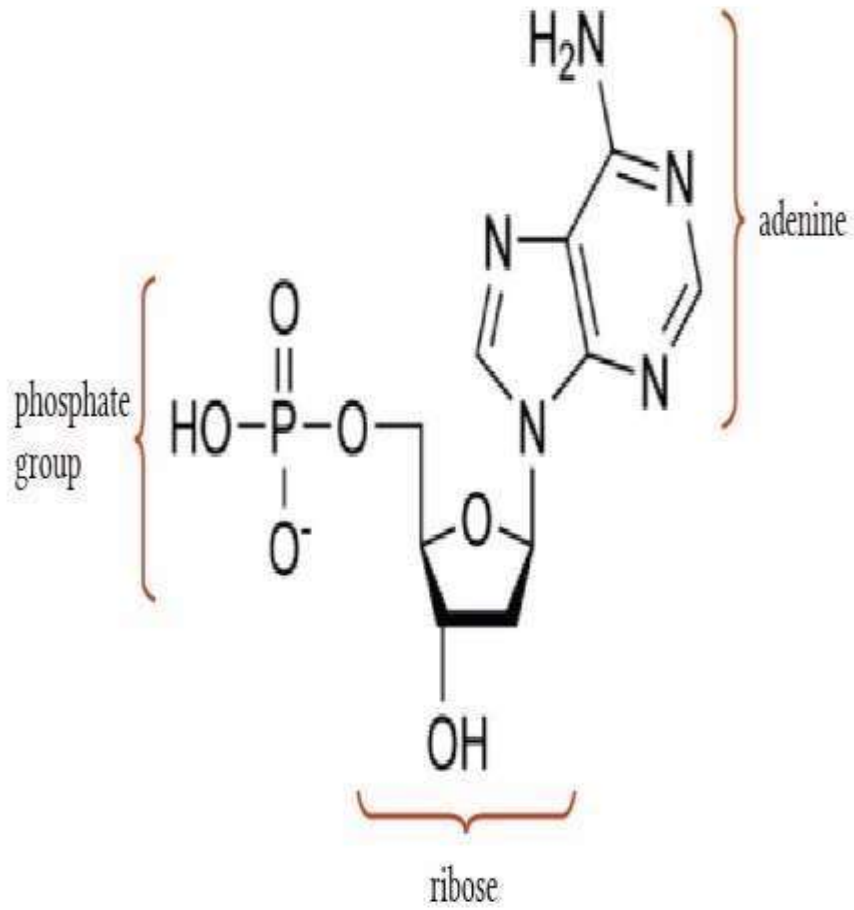
second messengers are short lived intracellular signaling molecules released by the cell to trigger physiological changes such as proliferation, differentiation, migration, survival and apoptosis

- cAMP is involved in the activation of protein kinases and regulates the effects of adrenaline and glucagon.
- cAMP also regulates the passage of Ca^{2+} through ion channels.
- cAMP and its associated kinases function in several biochemical processes including the regulation of glycogen, sugar and lipid metabolism by activating protein kinase.

- cAMP is a mediator of hormone action
- Activates protein kinase A
- Causes glycogenolysis
- Causes lipolysis.
- Modulates transcription
- Activates hormone secretion
- Increases gastric secretion.
- Regulates cell permeability to water



AMP



Cyclic AMP

