Medical Chemistry $\Delta G_{reac}<0$ Spontaneous reaction

Studies in „Medical chemistry", „Biochemistry". Studies of Gibs free energy change ↓calculation↓ conditions

$$\Delta G_{reac} = \Delta H_{reac} - T \cdot \Delta S_{reac}$$

ΔH_{reac} **Enthalpy**	ΔS_{reac} **Entropy**	**T Temperature**	ΔG_{reac} **Free energy**	**Spontaneous ability of reaction**
Dispersed energy $T\cdot\Delta S_{reac}>0$ is bound in surrounding and is lost as used free energy $\Delta G_{reac}<0$	$\Delta S_{reac}>0$ **Positive** entropy increases entropy change is positive	**decomposition** reaction	**AB → A + B**	Biochemical catabolism in living organisms consume the free energy in **spontaneous** reactions maintain organisms living.
1.		low **T** ↓ $\Delta H_{reac}>\lvert -T\cdot\Delta S_{reac}\rvert$	**Positive** $\Delta G_{reac}>0$ $\Delta H_{reac}-T\cdot\Delta S_{reac}>0$	**unfavorable** reaction at low temperature
Endothermic Positive $\Delta H_{reac}>0$	Dispersed energy is forming greater measure of chaos $\Delta S_{reac}>0$ **Positive . Spontaneous** catabolic reactions consume free energy change $\Delta G_{reac}<0$ for life mantanance of organisms 37° C in human as well as to supply the heat for organisms as reaction **Exothermic** $\Delta H_{reac}<0$.	high **T** ↑ $\Delta H^{\circ}_{reac}<\lvert -T\cdot\Delta S_{reac}\rvert$	**Negative** $\Delta G_{reac}<0$ $\Delta H_{reac}-T\cdot\Delta S_{reac}<0$	**spontaneous** reaction at high temperature
2. **Exothermic Negative** $\Delta H_{reac}<0$		any **T**	**Negative** $\Delta G_{reac}<0$ $\Delta H_{reac}-T\cdot\Delta S_{reac}<0$	thermodynamically **spontaneous** reaction at any temperature
Living cell proliferations and existing conditions for Life	$\Delta S_{reac}<0$ **Negative** entropy decreases entropy change is negative	**synthesis** reaction	**A + B → AB**	Biochemical anabolism energy accumulates and organize in compounds as synthesized the higher order as well decreases measure of chaos $\Delta S_{reac}<0$ **Negative**
3. **Endothermic Positive** $\Delta H_{reac}>0$	Synthesized as well as produced free energy $\Delta G_{reac}>0$ **Positive** accumulates in **photosynthesis**, in **ATP synthesis**, in **polypeptides** as well as in **proteins**, in **synthesized molecules**, living cells live and proliferates	any **T**	**Positive** $\Delta G_{reac}>0$ $\Delta H_{reac}-T\cdot\Delta S_{reac}>0$	**unfavorable** reaction thermodynamically forbidden at any temperature
4. **Exothermic Negative** $\Delta H_{reac}<0$		high **T** ↑ $\lvert\Delta H_{reac}\rvert<\lvert -T\cdot\Delta S_{reac}\rvert$	**Positive** $\Delta G_{reac}>0$ $\Delta H_{reac}-T\cdot\Delta S_{reac}>0$	**unfavorable** reaction at high temperature
		low **T** ↓ $\lvert\Delta H_{reac}\rvert>\lvert -T\cdot\Delta S_{reac}\rvert$	**Negative** $\Delta G_{reac}<0$ $\Delta H_{reac}-T\cdot\Delta S_{reac}<0$	**spontaneous** reaction at low temperature

In life important are negative change $\Delta S_{reac}<0$ of **entropy** and positive increase $\Delta G_{reac}>0$ of **free energy**! **Negative** change $\Delta S_{reac}<0$ dispersed energy $T\Delta S\downarrow$ decreases and into reaction accumulates supplied +**Q** energy into compound macroergic bonds as increase the free energy $\uparrow\Delta G_{reac}>0$.

$$\Delta H_{reac}=\uparrow\Delta G_{reac}+T\cdot\Delta S_{reac}\downarrow.$$

Opposite to spontaneous reaction $\downarrow\Delta G_{reac}>0$ negative change of free energy is lost energy.

Biochemical Reaction examples studies for students:

1. Glucose and oxygen **Green** plants **Photosynthesis**

← **Homeostasis**

red and **blue** light photons energy **E=hν** absorption heat and free energy accumulates in glucose and **oxygen** n substance

$\Delta H_{reac}>0$ = **-Q Endothermic** ΔH_{reac}= +2805,27 kJ/mol

6HCO$_3^-$+6H$_3$O$^+$ + **Q** + $\Delta G_{reaction}$ = **+2570,4** kJ/mol

photosynthetic process is **Endoergic** ΔG_r=**+2570,4** kJ/mol

free energy accumulates in 1 mol cytosolic glucose molecules $C_6H_{12}O_6$ biochemically in glycolise and Krebs cycle mitochondria „**combusted**" by **oxygen** O_2 to **combustion** products $CO_{2\,aqua}$ and H_2O along oxidative phosphorilation pathway.

direct reaction →

E=hν PRC

light **red** **blue**

photo synthesis →

← **combustion**

reverse reaction

←— Glycolysis, —— Oxidative Phosphorylation

Plant Enzymes Photo synthetic ←/ **Reaction Center**

glucose + **oxygen**

$C_6H_{12}O_6$+ **6** O_2+ +6H_2O

biochemical „**combustion**"

Krebs cycle in mitochondria

The Membrane potential 3rd **page** http://aris.gusc.lv/BioThermodynamics/MembraneElektrodsAM.doc

(page 9 http://aris.gusc.lv/BioThermodynamics/OxRedBiologicalW.doc)

2. **ATPase** driven **ATP synthesis** (**ATP** adenosine triphosphate **ATP^{4-}** anion pH=7.36)

One mole of glucose $C_6H_{12}O_6$ produces glycolytical, **mitochondrial** totally **36 ATP** molecules. Membrane integral enzyme **ATPase** nano engine to transfer **free** energy ΔG_{reac}**=+30.5 kJ/mol** for **Ribosome** Enzyme Complex per produced **ATP** molecule under proton gradient drives in to **Ribosome** reaction energy

ADP^{3-} +H$_2$PO$_4^-$

[H+] 2290 → Proton gradient over 1 **[H+]** →

[H+]=10^{-5} mol/Liter →**[H+]=10$^{-8.36}$** mol/L

pH=5 inter membrane spacee **4H$^+$** **ATPase** **4H$^+$** **pH=7.36** **mitochondria**

Ribosome Enzyme Complex Cofactor

ATP^{4-} +**H$_2$O** ↓

←——— **ATP^{4-}**

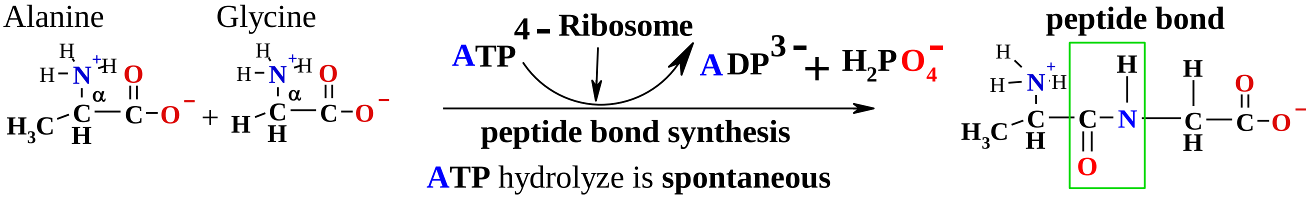
3. For free energy ΔG_{reac}**=+17.2 kJ/mol** transfer ↓

in Peptide Bond Formation Reaction is The **Ribosomal** protein synthesis: **ala + gly→ala-gly+ H$_2$O.**

To transfer from **ATP^{4-}** liberate and store **free energy** ΔG_{reac}**=+17.2 kJ/mol** per one mole of **peptide bond**.

Ribosome joint **peptide** synthesis with **ATP** hydrolyze: **free energy** $\Delta G_{hydrolize}$**= -30.5 kJ/mol** allows to store ΔG_{reac} **=+17.2 kJ/mol free energy** in reaction per one **mole** of **peptide bond**

Ala [A] Alanine | Gly [G] Glycine



ATP hydrolyze is **spontaneous** ΔG **=-30.5kJ/mol and**

total **reaction** sum **is** ↓ **spontaneous** too

ΔG_{reac} **=+17.2 - 30.5= -13.3 kJ/mol**

ΔG_{reac} **<0** negative

AlaninoGlycine Ala-Gly AG