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CATALASE indispensable **Life** molecular engine for reaction favored, hundred percents ● 100% efficiency

$Succinat^{2-}$+O_{2aqua} =>fumarate^{2-}+H_2O_{2aqua} ; pH=7.36 ; 41st page.

$\Delta G_{Hess}=\Delta G°_{H2O2}+\Delta G°_{fumarat}-\Delta G°_{O2}-\Delta G°_{Succinat}$=**-151,549-519,4688-(-522,414+16,4)**= **-165** kJ/mol;

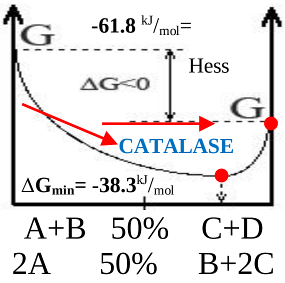
$\Delta G_{Hess}=\Delta H_{Hess}-T*\Delta S_{Hess}$=-48.16-298.15*0.0458= **-61.815**........kJ/mol **exoergic**

$\Delta G_{min}=\Delta G_{eq}=(E°_{Red}-E°_{Ox})*F*n$=(0,2512-0,4495)* 96485*2=(-0.1983)* 96485*2=**-38,3** kJ/mol;

$K_{eq}=exp(-\Delta G_{eq}/R/T)$=exp(382565,95/8,3144/298,15)=5057721 **favored** equilibrium

Essential unsaturated fatty acid elongation C20:4 and ethyl group **$-CH_2-CH_2-$** conversion to cis double bond **$^{H}>C=C<^{H}$** in peroxisomes is negative ΔG_{Hess}=**-61.8** kJ/mol free energy change, but minimized reaching equilibrium mixture **$\Delta G_{min}=\Delta G_{eq}$=-38.3** kJ/mol .

CATALASE in complex reaction sequence favors stabile unsaturated fatty acid product efficiency ● 100%: $K_{eq}=5057721=\dfrac{[Fumarate^{2-}]\cdot[H_2O_2]\swarrow \text{CATALASE}}{[Succinate^{2-}]\cdot[O_2]}$ because erasing peroxide to zero [H_2O_2]=0 mol/liter and process velocity limits only dehydrogenase enzyme. Attractors, enzymes reactivity are indispensable Brownian molecular engines for homeostasis, evolution and survival.



High rate protolysis activate $G_{H2O}+G_{HOOH}$=0+**274,5=274,5** kJ/mol to $G_{H3O+}+G_{HOO-}$=**22,4**+**328=350,4** kJ/mol;

1), 2), 3): **$2H_2O_2+2H_2O$** protolysis→ **$H_3O^++HOO^-$><$^-OOH+H_3O^+$** collision→ **$O_{2aqua}+2H_2O+2H_2O+Q$**;

1) Protolysis **$HOOH+H_2O \Leftrightarrow H_3O^++HOO^-$** pK_a=11.75 create collisions disproportionation **HOO^-><^{--}OOH**.

2) High activation energy E_a=79000 J/mol colliding **HOO^-><^-OOH** with slow velocity $\vec{k}$=1.416*10^{-16} $M^{-2}s^{-1}$ constant disproportionate **^-OOH** oxidize atoms to **O_{2aqua}** and second atoms **^-OOH** reduce about 2 **OH^-** ions,

3) which neutralizing to water: 2**OH^-**+2**H_3O^+**=>**$2H_2O+2H_2O$**. In summary produce **O_{2aqua}+2H_2O+2H_2O+Q**:

$$2H_2O_2+2H_2O \rightarrow H_3O^++HOO^- >< ^-OOH+H_3O^+ \rightarrow O_{2aqua}+2H_2O+2H_2O+Q$$ the Life resources .

Collision negative to positive **HOO^->Fe^{3+}** have E_a=29 J/mol indispensible law activation energy and with protonation the **His74** and Asn 147 velocity constant increases over absent **CATALASE** 30 million times as geometric factor **A** improve to **A=>**0.131:

$$H_2O_2+H_2O_2+Fe^{3+} \rightarrow \text{His74-}H^++HOO^->Fe^{3+}<^-OOH+\text{ Asn147-}H^+ \rightarrow O_{2aqua}+H_2O+H_2O+Q_{exothermic}+Fe^{3+}.$$

Protolysis activate transition state complex **oxygen**+ **water**+ **heat**+ CATALASE,
Negative anions collisions with positive iron **Fe^{3+}** ion produce life resources 30 million times faster.

reactivity: $\vec{v}_{enz}=k_{cat}/K_M\bullet[E]\bullet[H_2O_2]=3.6\bullet10^7\bullet[E]\bullet[H_2O_2]$, because collision **HOO^-=>Fe^{3+}** activation energy E_a=29 J/mol of Catalase is low. Usual Catalase concentration is small [E]=10^{-8} M and $\vec{v}_{enz}=0.36\bullet[H_2O_2]\ s^{-1}$. The geometric factor **A**=0.131 active collision fraction is 0.988 and 98.8% of total collisions are active and converting to products **O_{2aqua} + $2H_2O$ + Q** with velocity constant value is:

$$\vec{k}=A\bullet e^{-\frac{Ea}{RT}}=0.131\bullet e^{-\frac{29}{8,314\bullet298}}=0.131\bullet0.988=0.1296\ M^{-1}s^{-1},\ \vec{v}=\vec{k}\bullet[H_2O_2]^2=0.1296\bullet[H_2O_2]^2\ Ms^{-1}.$$

At absence catalyst activation energy of ions collisions **HOO^-><^-OOH** is very high **Ea**=79000 J/mol and low geometric factor **A**=0.01 make the Arrhenius velocity constant expression negligible small:

$$\vec{k}=A\bullet e^{-\frac{Ea}{RT}}=0.01\bullet e^{-\frac{79000}{8,314\bullet298}}=0.01\bullet1.419\bullet10^{-14}=1.419\bullet10^{-16}\ M^{-1}s^{-1}.$$

$$\vec{v}=\vec{k}\bullet[H_2O_2]^2=1.419\bullet10^{-16}\bullet[H_2O_2]^2\ Ms^{-1}\ ;\text{if } [H_2O_2]=1\ M\ ;\ \sqrt{\vec{v}}=\sqrt{\vec{k}}\bullet[H_2O_2]=1.191\bullet10^{-8}.$$

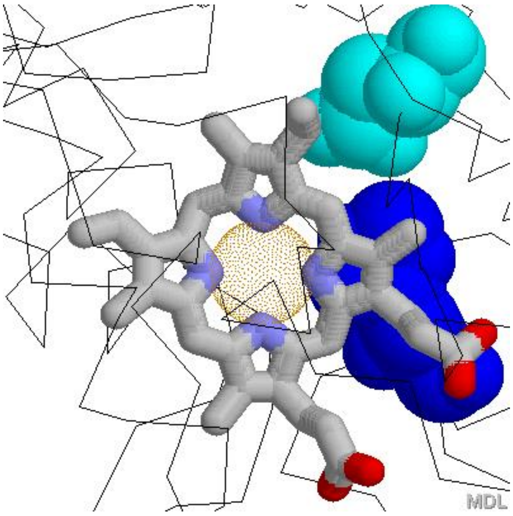
As $\sqrt{\vec{v}}={}^{CAT}\sqrt{\vec{k}}\bullet[H_2O_2]=\mathbf{0.36}\bullet[H_2O_2]$; $\dfrac{^{CAT}\sqrt{\vec{k}}}{\sqrt{\vec{k}}}=\dfrac{0,36}{1,19\bullet10^{-8}}$ = (4.) 30•10^6 times greater velocity constant increase

$\Delta G_{eqStandard}=(E°_{H2O2}-E°_{H2O2Ox})*F*n$=(0,4495-1,6855)*96485*2=(-1,1845)*96485*2= **-238,5**....kJ/mol ;

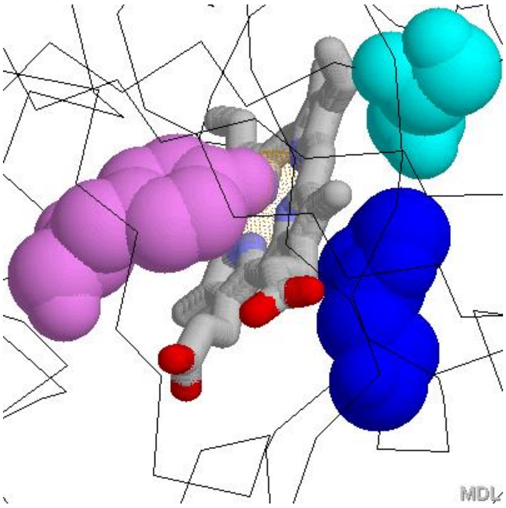
$\Delta G_{HessAlberty}=G_{O2}+2G_{H2O}-2G_{H2O2}$=330+2*(0)-(2***284**)=**-238**........ kJ/moll **;** **Alberty**

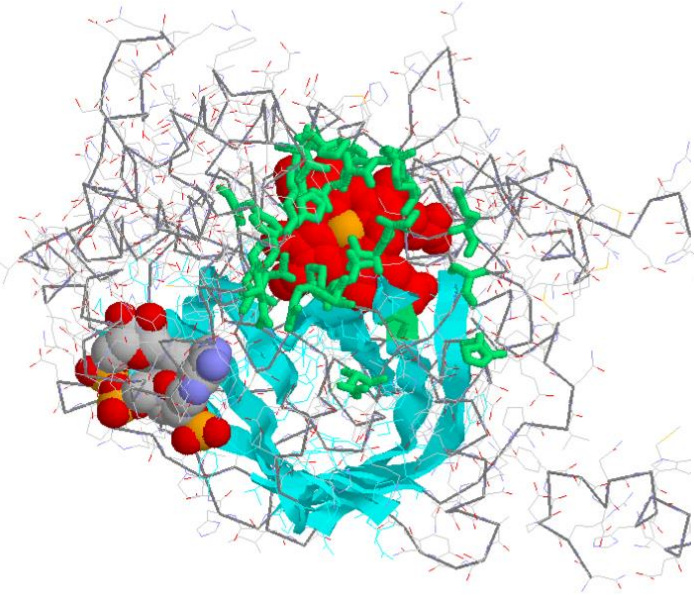
Absolute potential **scale** is coinciding with **Alberty** **absolute** free energy **scale.**

$$\frac{[O_2]_{aqua}\cdot[H_2O]^2}{[H_2O_2]^2_{aqua}}=K_{eqStandard}=K_{H2O2}=exp(-\Delta G_{eqStandarta}/R/T)=exp(238500/8,3144/298,15)=10^{41,8}........$$



Asn147, His74, Tyr357





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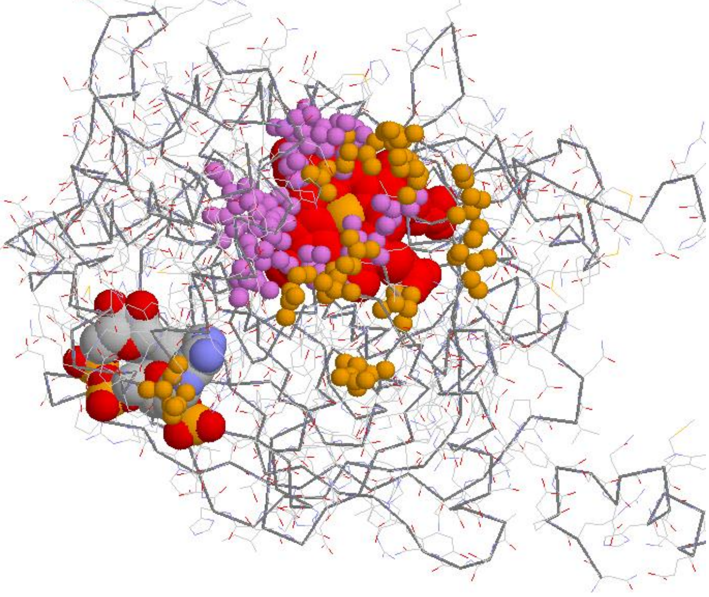
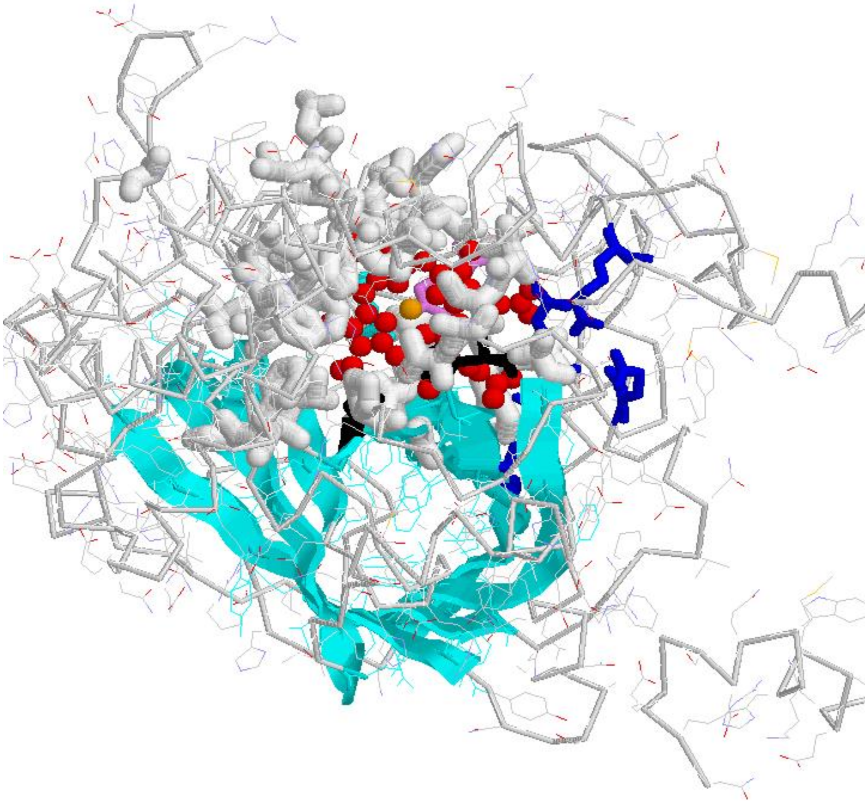


PiltuveHydroPhylPhob.jpg

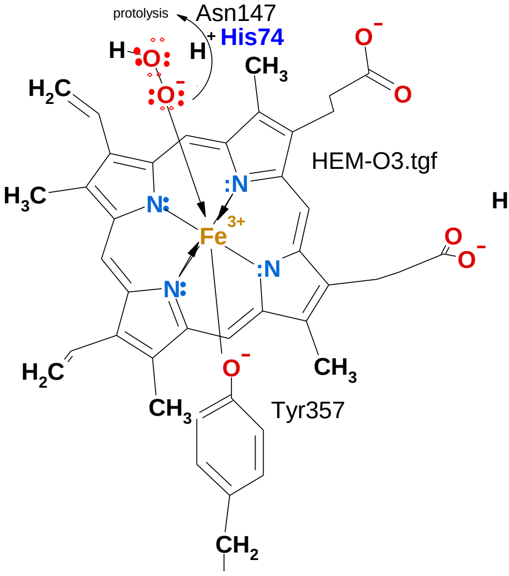


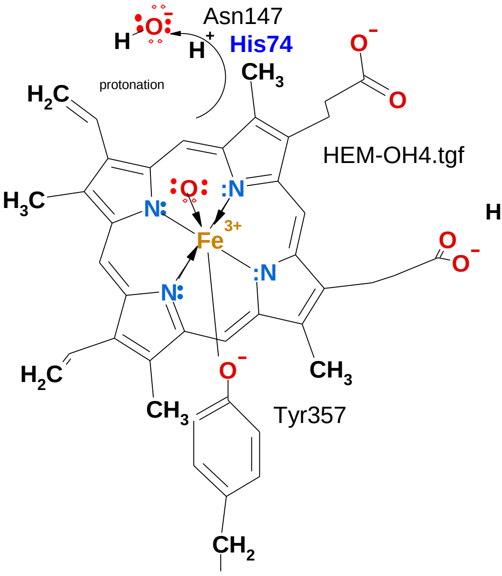
PiltuveHydroPhylPhob.jpg CATALASE funnel with iron(III) **Fe**(**III**) in coordination center

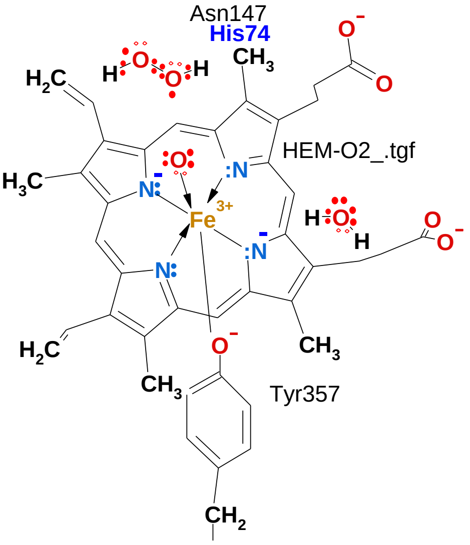
Advanced Studies of Chromo Protein CATALASE Heme pocket active site

Experimental research:

Oxidised oxygen atom colliding iron Ox **H-O-Fe(IV)** left reduced second oxygen atom **HO$^-$**



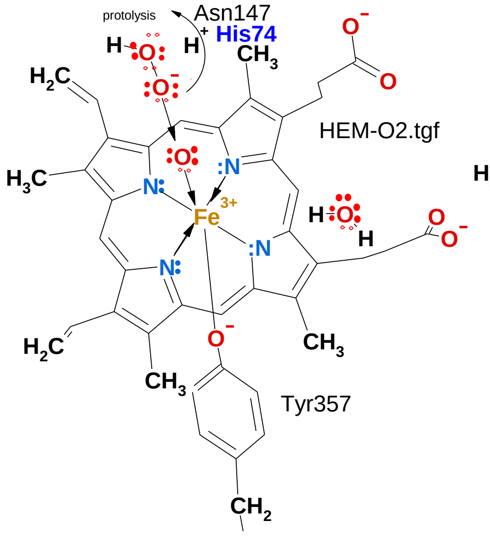


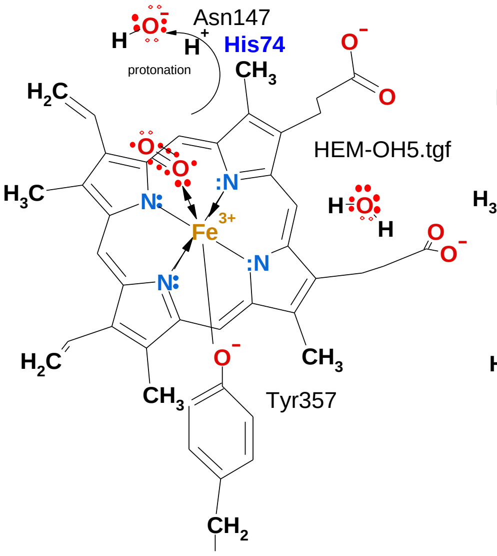


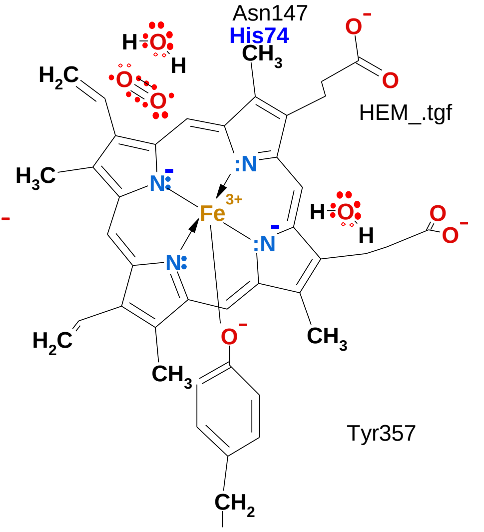
Heme pocket with 28 hydrophobic amino acids – in waterless medium oxidation-reduction reaction absent:

Val72,Val73,Ala75,Val115,Ala116,Pro128,Gly130,Val145,Gly146,Phe153,Ile154,Ala157,Leu159,Phe160,

Pro161,Phe163,Ile164,Leu198,Leu298,Ala332,Phe333,Pro335,Met349,Leu350,Gly352,Ala356,Pro358,Ala434







Dismutation reaction mechanism in steps with protonation **His74**, Asn174 of peroxide deprotonation in negative charged anion oxygen atom collisions to active site positive atom iron charge **Fe(III)-O**-Tyr357-**E**:

1. **H-O-O-H**$_{\text{protolysis}}$+**His74**+**Fe(III)-O**-Tyr357-**E**=>**H$^+$-His74**$_{\text{protonate}}$+**HOO$^-$**→+**Fe(III)-O**-Tyr357-**E** ....
2. **H$^+$His74**$_{\text{protonation}}$+**HOO$^-$**→+**Fe(III)-O**-Tyr357-**E**=>**HO$^-$**$_{\text{Red}}$+**H$^+$His74**$_{\text{protonate}}$+Ox**O-Fe(IV)-O**-Tyr357-**E**.......
3. **HO$^-$**$_{\text{Red}}$+ **H$^+$-His74**$_{\text{protonate}}$+Ox**O-Fe(IV)-O**-Tyr357-**E**=>$_{\text{Red}}$**H$_2$O**+**His74**+Ox**O-Fe(IV)-O**-Tyr357-**E** ....
4. =>**H-O-O-H**$_{\text{protolysis}}$+Asn147+**O-Fe(IV)-O**-Tyr357-**E** =>**H$^+$**Asn147+**HOO$^-$**→+**O-Fe(IV)-O**-Tyr357-**E** ....
5. **H$^+$**Asn147+**HOO$^-$**→+**O-Fe(IV)-O**-Tyr357-**E**=>**HO$^-$**$_{\text{Red}}$+**H$^+$**Asn147+Ox**O-O-Fe(IV)-O**-Tyr357-**E**.................
6. =>**HO$^-$**$_{\text{Red}}$+**H$^+$**Asn147+Ox**O-O-Fe(IV)-O**-Tyr357-**E**=>$_{\text{Red}}$**H$_2$O**+Asn147+Ox**O-O-Fe(IV)-O**-Tyr357-**E** ....
7. $_{\text{Red}}$**H$_2$O**+Ox**O-O-Fe(IV)-O**-Tyr357-**E**=>$_{\text{Red}}$**H$_2$O**+Ox**O=O**+-**Fe(III)-O**-Tyr357-**E** ....

Summary: 2**H$_2$O$_2$**+**CAT**→**H$_3$O$^+$**+**HOO$^-$**>**Fe(III)**<$^-$**OOH**+**H$_3$O$^+$**→**O$_2$**$_{\text{aqua}}$+**2H$_2$O**+**Q**$_{\text{exothermic}}$+**CAT**

Protolysis activate transition state complex **oxygen**+ **water**+ **heat**+ CATALASE:

1. Colliding oxygen atom oxidized and deprotonate: Ox **O-Fe(III)** and **H$^+$His74**, Asn174 ;
2. second oxygen atom reduced **HO$^-$**Red and protonate.

High rate protolysis peroxide reduction and oxidation = disproportionation.

Calculate ΔH_{Hess}, ΔS_{Hess}, ΔG_{Hess}**.** Reaction is **exothermic**, **athermic**, **endothermic**? Peroxide **2H:-••:O-:-O:••-:H**
conversion to **O_{2aqua} +2H_2O +Q**, using table data! Menshion will be reaction **exoergic** or **endoergic**!

$\Delta G_{Hess}=\Delta G°_{O2}+2\Delta G°_{H2O}-2\Delta G°_{H2O2}$=**16,40**+2*(**-151,549**)-(2***-48,39**)=**-189,9**......... $^{kJ}/_{moll}$ **exoergic**

Substance	$\Delta H°_H$ $^{kJ}/_{mol}$	$\Delta S°_H$ $^{J}/_{mol/K}$	$\Delta G°_H$ $^{kJ}/_{mol}$
H_3O^+	-285,81	-3,854	-213,275
$H_2O_{2(aq)}$	**-191,99**	**-481,688**	**-48,39**
$H_2O_{2(aq)}$	-191,17	143,9	-134,03
O_{2aqua}	**-11.70**	**-94,2**	**16,40**
O_{2aqua}	-11,715	110,876	16,4
H_2O	**-286,65**	**-453,188**	**-151,549**
H_2O	-285,85	69,9565	-237,191

$2H_2O_{2aq}$=>O_{2aqua}+$2H_2O$+Q+ΔG

BiochemThermodynamic 2006 Masachusets Technology Institute
University Alberta 1997.

.$\Delta H_{Hess}=\Delta H°_{O2}+2\Delta H°_{H2O}-2\Delta H°_{H2O2}$=**-201,02** $^{kJ}/_{mol}$ =-201,06 $^{kJ}/_{mol}$
=**-11,7**-2***286,65**-(2***-191,99**)=**-201,02** $^{kJ}/_{mol}$;
=-11,7-2*285,85-(2*-191,17)=-201,06 $^{kJ}/_{mol}$;

$\Delta S_{dispersed}=-\Delta H_H/T$=-(**-201,02**)/298,15=**674,2** $^{J}/_{mol/K}$; $\Delta S_{dispersed}=-\Delta H_H/T$=-(-201,06)/298,15=674,36 $^{J}/_{mol/K}$;

$\Delta S_{Hess}=\Delta S°_{O2}+2\Delta S°_{H2O}-2\Delta S°_{H2O2}$=**-94,2**+2***-453,188**-(2***-481,688**)=**-37,2** $^{J}/_{mol/K}$**;**

$\Delta S_{Hess}=\Delta S°_{O2}+2\Delta S°_{H2O}-2\Delta S°_{H2O2}$=110,876+2*69,9565-(2*143,9)=-37 $^{J}/_{mol/K}$**;**

$\Delta S_{kopēja}=\Delta S_H+\Delta S_{dispersed}$**=-37,2+674,2=637**.....$^{J}/_{mol/K}$ $\Delta S_{kopēja}$=-37,011+674,36=637,35......$^{J}/_{mol/K}$**;**

$\Delta G_{Hess}=\Delta H_H-T*\Delta S_H$=**-201,02**-298,15***-0,0372=-189,9** $^{kJ}/_{mol}$ **eksoerģiska patvaļīga**.

$\Delta G_{Hess}=\Delta H_H-T*\Delta S_H$=-201,06-298,15*-0,037=-190 $^{kJ}/_{mol}$;

T•$\Delta S_{kopēja}$=**0,637***298,15=**189,9** $^{kJ}/_{mol}$; T•$\Delta S_{kopēja}$=0,63735*298,15=190 $^{kJ}/_{mol}$;

Half reactions RedOx Nernst's equations for reduced and for oxidised form balance of electrons:

Red $H_2O_2+2H_2O=O_2+2H_3O^++2e^-$; **E**$^{\circ}_{H2O2}$=0,4495 V **Absolute** standard potential;
Ox H_2O_2 + 2 H_3O^+ + 2 e^- = 4 H_2O ; **-E**$^{\circ}_{\mathbf{Ox}H2O2}$=-1,6855V **Absolute iverse** standard potential .

$\Delta G_{eqStandard}$=(**E**$^{\circ}_{H2O2}$-E$^{\circ}_{H2O2Ox}$)***F*n**=(0,4495-1,6855)*96485*2=(-1,1845)*96485*2= **-238,5**....$^{kJ}/_{mol}$;

$\Delta G_{HessAlberty}=G_{O2}+2G_{H2O}-2G_{H2O2}$=330+2*(0)-(2***284**)=**-238**........ $^{kJ}/_{moll}$ **;** **[Alberty]**

Absolute potential **scale** is coinciding with **[Alberty]** **absolute** free energy **scale.**

G_{H2O2} =G_{O2aqua}**+2***G_{H2O}+$\Delta G_{AlbertyStandard}$=**330+2*0+218,9**=2***274,5**=**548,9** $^{kJ}/_{mol}$;;

H_2O_2]=1 M Biochemistry concentrations [O_{2aqua}]=6*10^{-5} M, [H_3O^+]=$10^{-7,36}$ M, [H_2O]=55,3 M.

$$\frac{[O_2]_{aqua}\cdot[H_2O]^2}{[H_2O_2]^2_{aqua}}=\mathbf{K}_{\mathbf{eq}Standard}=\mathbf{K}_{H2O2}=\mathbf{exp(-\Delta G}_{\mathbf{eq}Standarta}\mathbf{/R/T})=\exp(238500/8,3144/298,15)=10^{41,8}........$$

$E_{Red}=E°_{H2O2}$+0.0591/2•lg([O_{2aqua}]*[H_3O^+]^2/[H_2O_2]/[H_2O]^2)=0,4495+0.0591/2*lg(6*10$^{\wedge(-5)}$*10$^{\wedge(-7.36*2)}$/1/55.3$^{\wedge2}$)=-0.2132 V
$-E_{Ox}=-E°_{H2O2Ox}$+0.0591/2•log([H_2O_2]*[H_3O^+]^2/[H_2O]^4)= -1,6855+0.0591/2*lg(1*10$^{\wedge(-7.36*2)}$/55.3$^{\wedge4}$)= -2,3265 V

[H_2O_2]=1 M; **ΔG_{eq}**$_{BioChem}$=(**E**$^{\circ}_{\mathbf{Red}}$**-E**$^{\circ}_{\mathbf{Ox}}$)***F*n**=(-0,2132-2,3265)*96485*2=(-2,5397)*96485*2=**-490,1** $^{kJ}/_{mol}$;

$\Delta G_{Alberty}=G_{O2Biochem\_arteriaj}$**+2***$G_{H2OBioChemistry}$**-2***$G_{H2O2}$=**78,08+2*85,64-2*364,79**=**-480,22** $^{kJ}/_{mol}$;

Exothermic and exoergic **H_2O_2** dismutation reaction Hess law

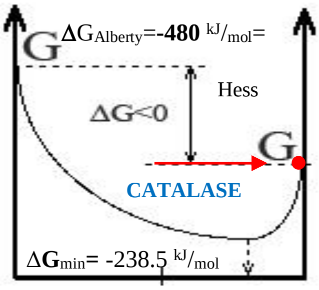
Homeostasis free energy change Δ**G**$_{Alberty}$=**-480,22**..........$^{kJ}/_{mol}$ is negative,

Hess **[Alberty]** free energy change $\Delta G_{HessAlberty}$=**-238**........$^{kJ}/_{mol}$ is negative,

Absolute potential scale $\Delta G_{eqStandard}$=**-238,5**..........$^{kJ}/_{mol}$ coinsiding with Absolute free energy scaling. reching equilibrium mixture constant

K$_{\mathbf{eq}BioChem}$=$10^{41,8}$.............

Le Chatelier principle mean Prigogine attractor the free energy change minim ΔG_{min} reaching. High rate protolysis attractors pH=7,36, air oxygen 20,95% stay at equilibrium state, while homeostasis irreversibly continues, as is non equilibrium state. Prigogine attractors of Nobel Prize in Chemistry since 1977th . CATALAE erase peroxide molecules H_2O_2 in 100% efficiency for ω=6, ω=3 essential fatty acids elongation synthesis in peroxisomes. CATALASE reactivity is indispensible Brownian molecular engine for the irreversible homeostasis evolution and survival.



A+A 50% B+2C.
reactants 2**$H_2O_{2(aq)}$**
products **O_{2aqua}+2H_2O**

High rate protolysis $\mathbf{HOOH+H_2O \Leftrightarrow H_3O^+ + HOO^-}$ pKa=11,75 make possible peroxide anions collisions $\mathbf{HOO^- >< {}^-OOH}$ as disproportionation reactants in active complex transition state, what create indispensible activation energy $\mathbf{E_a}$=79000 $^J/_{mol}$ with slow velocity constant $\vec{k}=1.416*10^{-16}\ M^{-1}s^{-1}$ of product formation :

$$2H_2O_2+2H_2O \rightarrow H_3O^+ + HOO^- >< {}^-OOH + H_3O^+ \rightarrow O_{2aqua}+2H_2O+2H_2O\ .$$

Referring to water and $\mathbf{CO_{2gas}}$ zero $G_{H2O}=G_{CO2gas}=0\ ^{kJ}/_{mol}$ level activate homeostasis products free energy are peroxide, hydroxonium and peroxide ions: $G_{H2O2}=\mathbf{274.5}\ ^{kJ}/_{mol}$; $G_{H3O+}+G_{HOO-}=22.44+418.32=440.76\ ^{kJ}/_{mol}$;
At present Catalase for colliding negative and positive ions $\mathbf{HOO^- > Fe^{3+}}$ have $\mathbf{E_a}$=29 $^J/_{mol}$ indispensible activation energy : $\mathbf{H_2O_2+H_2O_2+Fe^{3+} \rightarrow His74\text{-}H^+ + HOO^- > Fe^{3+} < {}^{--}OOH}+\text{Asn147-}\mathbf{H^+ \rightarrow O_{2aqua}+H_2O+H_2O+Q_{exothermic}+Fe^{3+}}$.
Protonate **His74** and than Asn147 Catalase velocity is $^{CAT}\sqrt{\vec{k}}\ /\sqrt{\vec{k}} = \frac{0{,}36}{1{,}19 \bullet 10^{-8}}$ =30•10⁶ million times faster.

Free energy of activate homeostasis products referring to water and $\mathbf{CO_{2gas}}$ zero $G_{H2O}=G_{CO2gas}=0\ ^{kJ}/_{mol}$ are peroxide, hydroxonium and anion of peroxide: $G_{H2O2}=364.8\ ^{kJ}/_{mol}$; $G_{H3O+}+G_{HOO-}=22.44+418.32=440.76\ ^{kJ}/_{mol}$;
High rate protolysis Attractors Catalase reactivity is indispensable molecular engine producing the life resources : **oxygen**+ **water**+ **heat** ($\mathbf{O_{2aqua}+2H_2O+Q}$). Catalases erase peroxide molecules thirty million times faster. So activate perfect order of homeostasis reactions with hundred percents ● 100% efficiency.

High rate protolysis $\mathbf{HOOH+H_2O \Leftrightarrow H_3O^+ + HOO^-}$ being at equilibrium state, while irreversible homeostasis including peroxide disproportionation continues as non-equilibrium state. Protolysis high rate equilibrium state of deprotonation promote the water concentration $[\mathbf{H_2O}]$=55.3 M as reactant $\mathbf{HOOH+H_2O \Leftrightarrow}$ and homeostasis established attractor value pH=7,36 as$\Leftrightarrow \mathbf{H_3O^+ + HOO^-}$ hydroxonium ion $[H_3O^+]=10^{-7{,}36}$ M concentration. Both support in square protolysis disproportionation reactants in active complex transition state $[\mathbf{H_2O}]^2 \Leftrightarrow [\mathbf{H_3O^+}]^2$ of peroxide anions collisions, what generate indispensible activation energy $\mathbf{E_a}$=79000 $^J/_{mol}$:

$$2H_2O_2+2H_2O \rightarrow H_3O^+ + HOO^- >< {}^-OOH + H_3O^+ \rightarrow O_{2aqua}+4H_2O+Q_{exothermic}.$$

toxic compound — transition state active complex — biological goods **oxygen** + **water** + **heat** .

Peroxide disproportionation velocity depends on colliding peroxide anions $\mathbf{HOO^- => <= {}^-OOH}$ activation energy $\mathbf{E_a}$=79000 $^J/_{mol}$ and geometric factor A=0.01 value.

Peroxide disproportionation velocity increases on decrease activation energy $\mathbf{E_a}$=29 $^J/_{mol}$ of colliding peroxide anions $\mathbf{HOO^-}$ and iron cation $\mathbf{Fe^{3+}}$ in CATALASE active site pocket which geometric factor increases 13^{theen} times reaching value A=0.13.

$$\mathbf{H_2O_2+H_2O_2+CAT\text{-}\ Fe^{3+} \rightarrow H^+ + HOO^- > Fe^{3+} < {}^-OOH + H^+ \rightarrow O_{2aqua}+H_2O+H_2O+Q_{exothermic}+CAT\text{-}\ Fe^{3+}.}$$

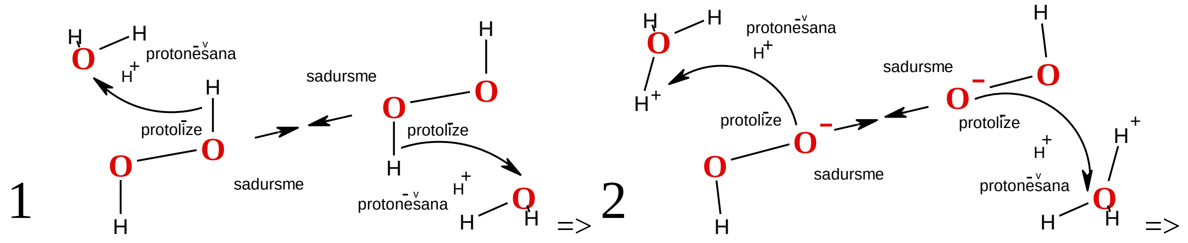
CATALASE reactivity as molecular engine factory producing resources $\mathbf{O_{2aqua}+2H_2O+Q}$ for life.

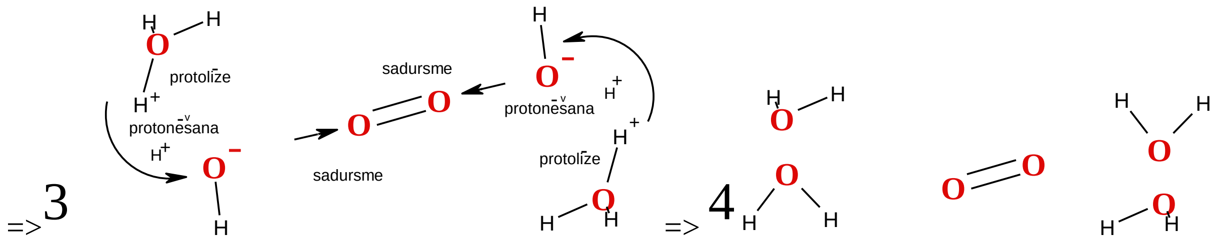
Results and Conclusions Summary

1. **Catalyst** CATALASE (CAT) is <u>involved</u> to reaction active transition state complex formation.
$\mathbf{H_3O^+ + HOO^- > CAT < {}^-OOH + H_3O^+}$ and on finish released into products free unchanged CAT.
2. **Catalyst** (CAT) <u>decrease</u> activation energy $\mathbf{E_a}$ from 79000 $^J/_{mol}$ to 29 $^J/_{mol}$ times 2724 less.
3. **Catalyst** (CAT) <u>improve</u> geometric factor A=0.01 to A=0.13 and is 13^{theen} times better. ....
4. **Catalyst** CATALASE <u>increase</u> reaction velocity constant $\vec{k}$ from $1.9 \bullet 10^{-8}\ M^{-1}s^{-1}$ to $0.36\ M^{-1}s^{-1}$ ....
times 30•10⁶ thirty million more. ....
5. High rate protolysis attractors for Catalase reactivity is indispensable life molecular engine converting to ● 100% efficiency the life resources production: **oxygen**+ **water**+ **heat** ($\mathbf{O_{2aqua}+2H_2O+Q}$).......................
6. CATALASE erase peroxide molecules 30•10⁶ thirty million times faster...................................
7. Absence of catalyst at collision indispensible activation energy Ea=79000 $^J/_{mol}$ for three reactions:

$$\mathbf{2H_2O_2+2H_2O =^{1)}\rightarrow H_3O^+ + HOO^- >< OOH + H_3O^+ =^{2)}\rightarrow O_{2aqua}+2H_3O^+ + 2OH^- =^{3)}\rightarrow O_{2aqua}+4H_2O+Q;}$$

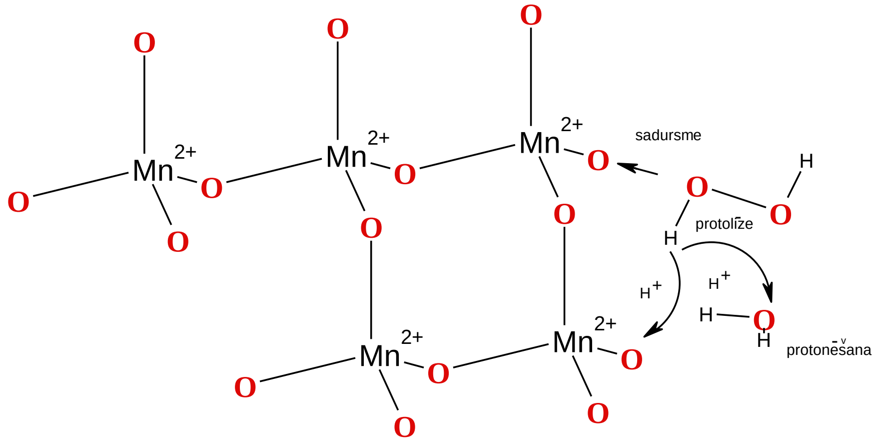
1) Protolysis reaction , than **2)** oxidation of colliding **O** atoms and reduction second **O** atom to hydroxide $\mathbf{OH^-}$
3) finally neutralization.

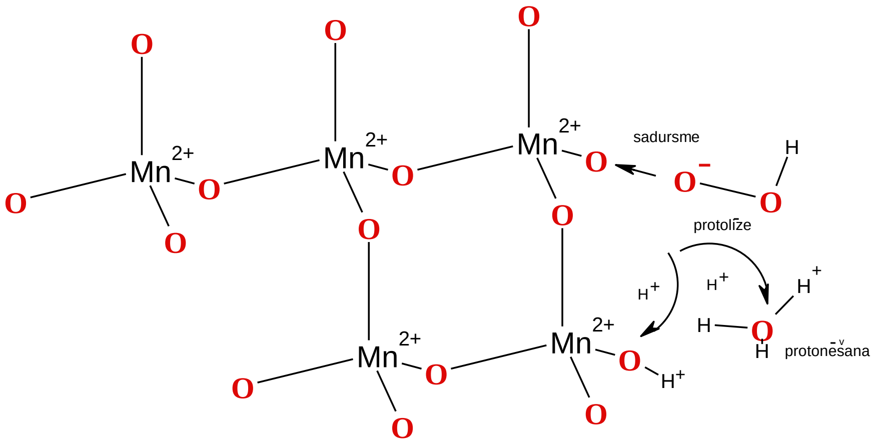


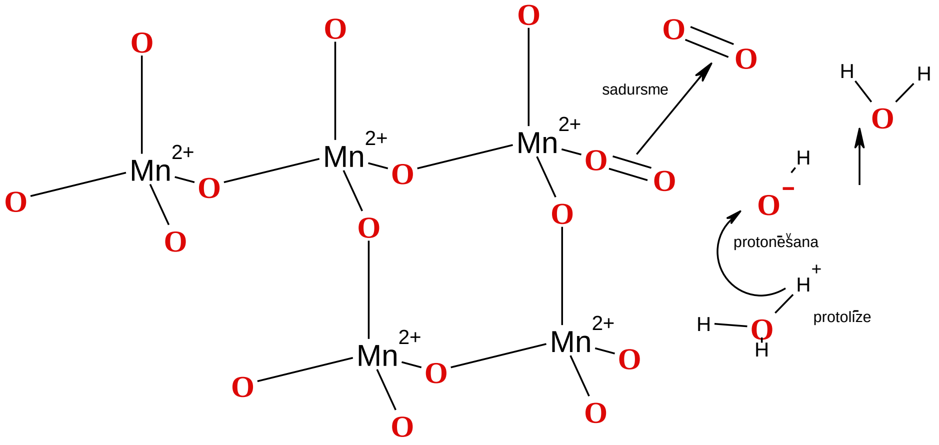


$\mathbf{H_2O_2 + H_2O_2 + CAT \rightarrow H^+ + HOO^- > CAT < {}^-OOH + H^+ \rightarrow O_{2aqua} + H_2O + H_2O + Q_{exothermic} + CAT}$

Catalyst by manganese(II) oxide MnO.







Catalyst by iron(III) oxide Fe_2O_3.