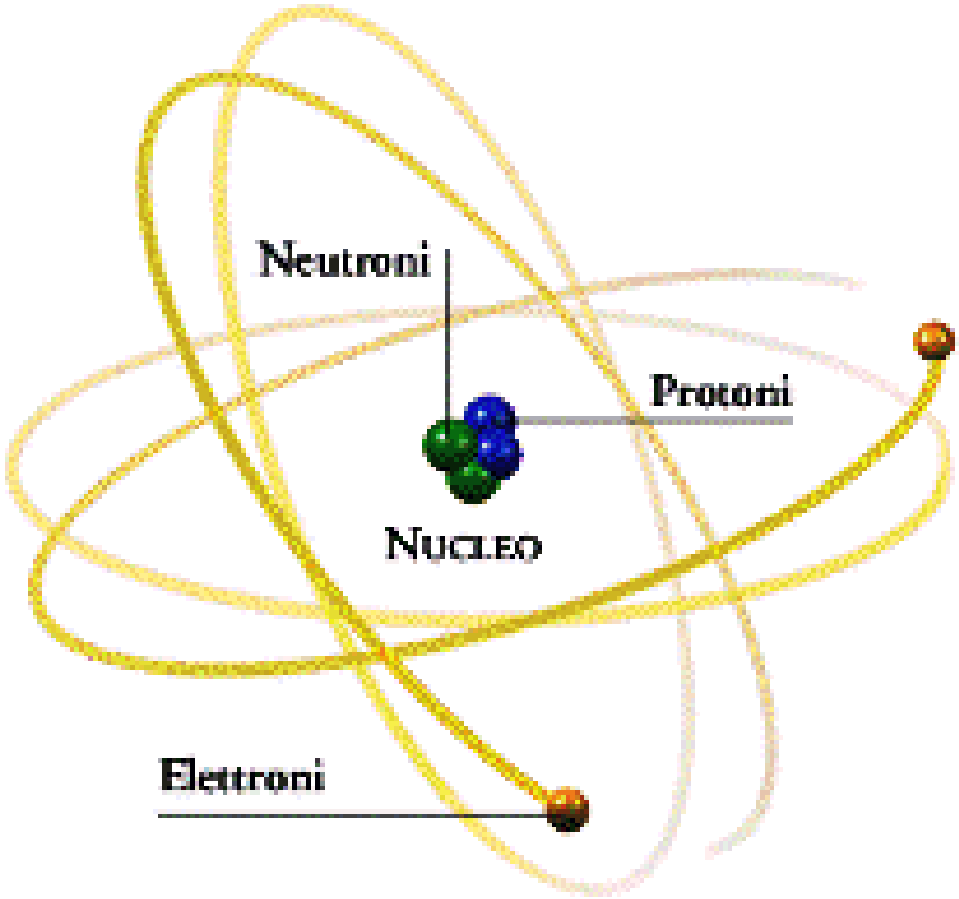
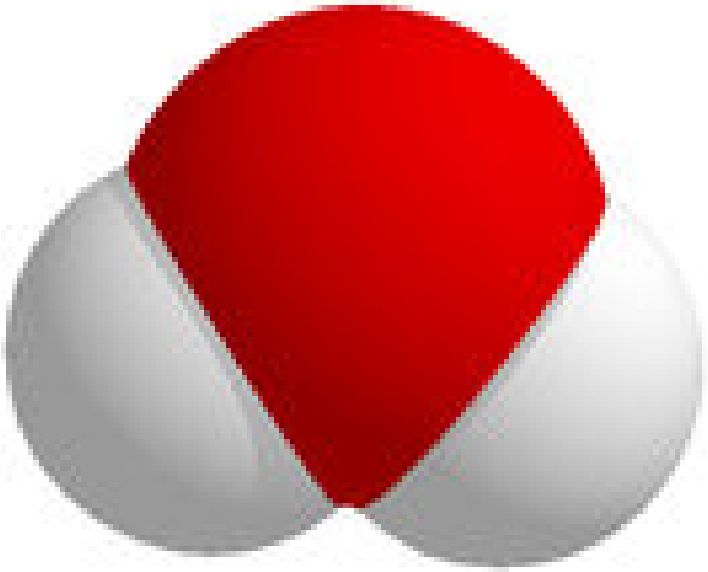
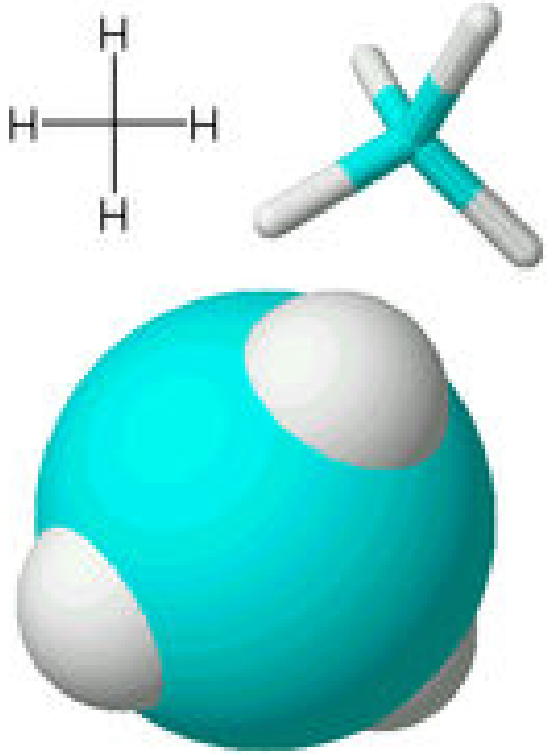
Chimica in miniatura:reazioni e trasformazioni nella cellula

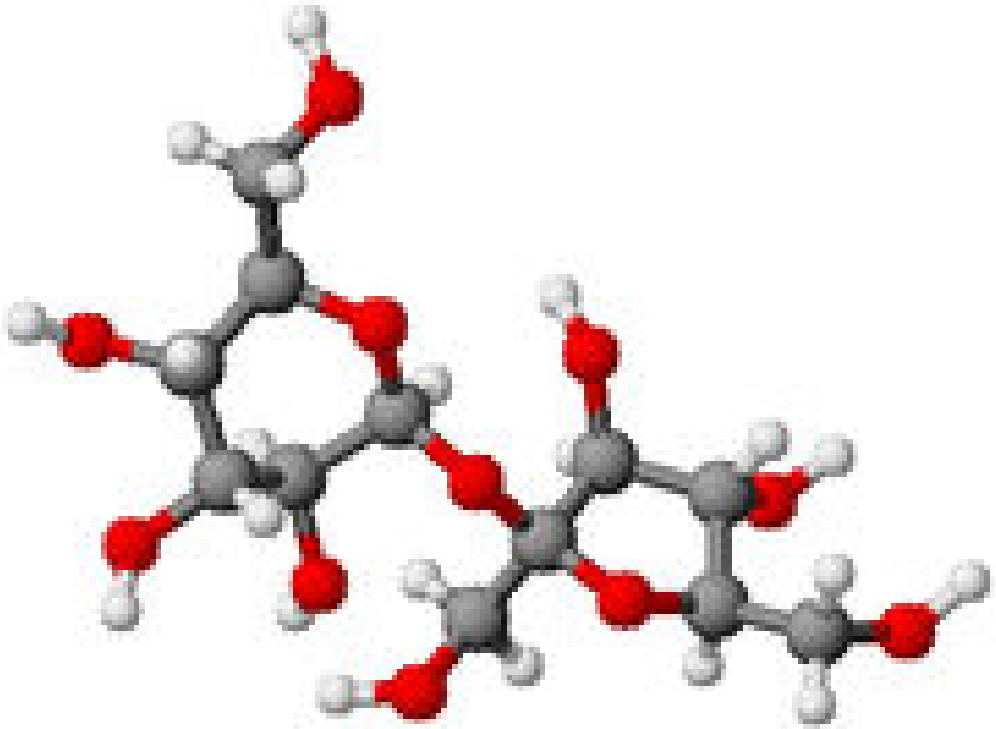
- Atomi ,molecole, Legami chimici, cosa tiene insieme gli atomi tra loro,

- Energia e forza di legame

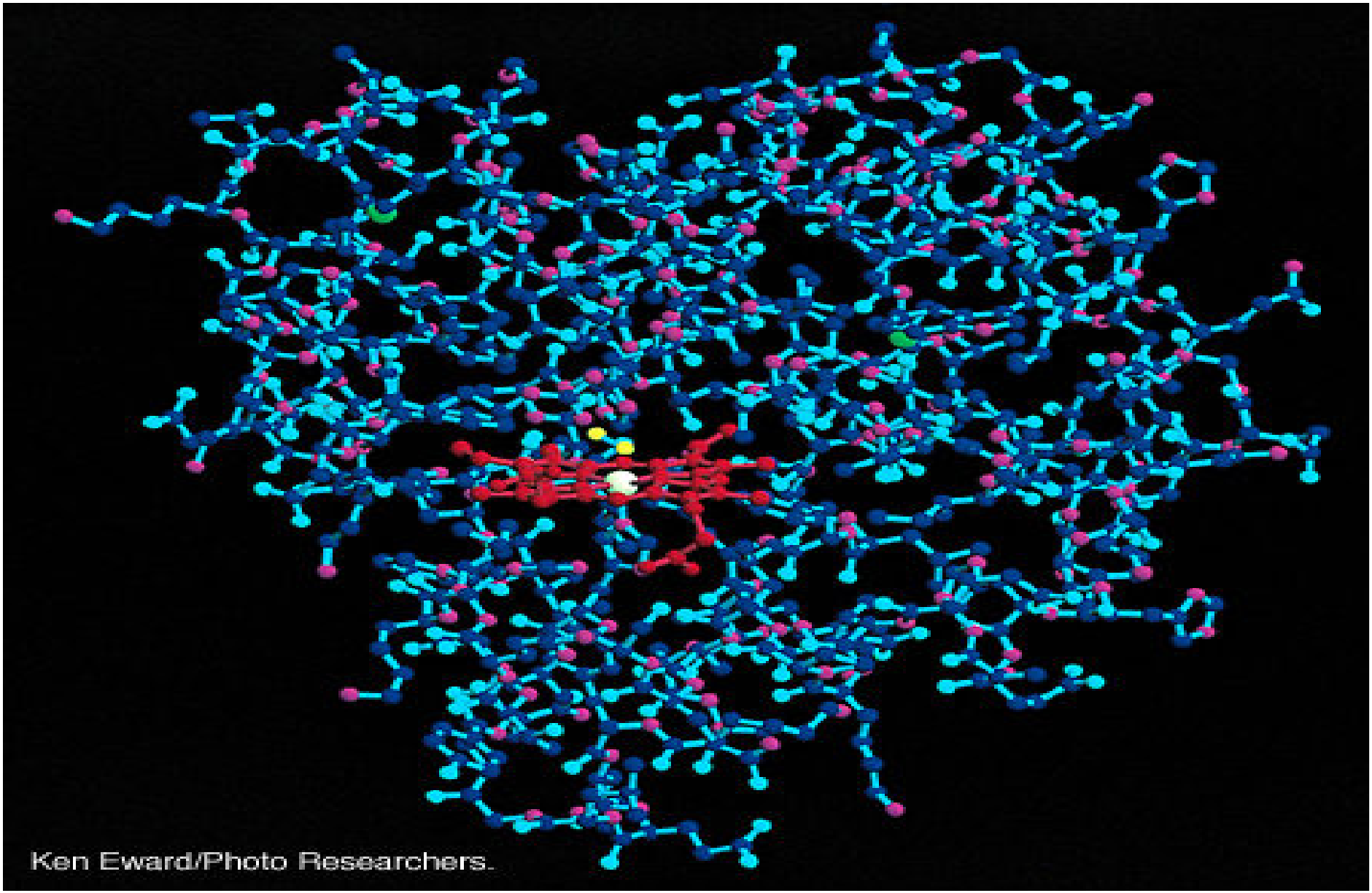

Neutroni
Protoni
Nucleo
Elettroni




H
H
H
H



Struttura terziaria di una proteina con eme




Courtesy of Nelson Max.

$$[T_{\mathrm{e}} + T_{\mathrm{n}} + V_{\mathrm{ne}}(\mathbf{R},\mathbf{r}) + V_{\mathrm{ee}}(\mathbf{r}) + V_{\mathrm{nn}}(\mathbf{R})]\,\Psi_{\mathrm{total}}(\mathbf{R},\mathbf{r}) = E(\mathbf{R})\Psi_{\mathrm{total}}(\mathbf{R},\mathbf{r})$$

$$[T_{\mathrm{e}} + V_{\mathrm{ne}}(\mathbf{R},\mathbf{r}) + V_{\mathrm{ee}}(\mathbf{r})]\,\psi_{\mathrm{e}}(\mathbf{R},\mathbf{r}) = E_{\mathrm{e}}(\mathbf{R})\psi_{\mathrm{e}}(\mathbf{R},\mathbf{r})$$

$$\left(-\sum_i \frac{\hbar^2}{2M_i}\nabla_R^2 + [T_{\mathrm{e}} + V_{\mathrm{ne}}(\mathbf{R},\mathbf{r}) + V_{\mathrm{ee}}(\mathbf{r}) + V_{\mathrm{nn}}(\mathbf{R})]\right)\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})\psi_{\mathrm{n}}(\mathbf{R}) = E(\mathbf{R})\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})\psi_{\mathrm{n}}(\mathbf{R})$$

$$\nabla_R^2[\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})\psi_{\mathrm{n}}(\mathbf{R})] = \psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})\nabla_R^2\psi_{\mathrm{n}}(\mathbf{R}) + 2[\nabla_R\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})]\,\nabla_R\psi_{\mathrm{n}}(\mathbf{R}) + \psi_{\mathrm{n}}(\mathbf{R})\nabla_R^2\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})$$

$$-\sum_i \frac{\hbar^2}{2M_i}\left(\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})\nabla_R^2\psi_{\mathrm{n}}(\mathbf{R}) + 2[\nabla_R\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})]\,\nabla_R\psi_{\mathrm{n}}(\mathbf{R}) + \psi_{\mathrm{n}}(\mathbf{R})\nabla_R^2\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})\right) +$$

$$+ [T_{\mathrm{e}} + V_{\mathrm{ne}}(\mathbf{R},\mathbf{r}) + V_{\mathrm{ee}}(\mathbf{r}) + V_{\mathrm{nn}}(\mathbf{R})]\,\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})\psi_{\mathrm{n}}(\mathbf{R}) = E(\mathbf{R})\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})\psi_{\mathrm{n}}(\mathbf{R})$$

$$2[\nabla_R\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})]\,\nabla_R\psi_{\mathrm{n}}(\mathbf{R}) + \psi_{\mathrm{n}}(\mathbf{R})\nabla_R^2\psi_{\mathrm{e}}(\mathbf{r},\mathbf{R})$$

$$\left[-\sum_i \frac{\hbar^2}{2M_i}\nabla_R^2 + E_{\mathrm{e}}(\mathbf{R}) + V_{\mathrm{nn}}(\mathbf{R})\right]\psi_{\mathrm{n}}(\mathbf{R}) = E_{\mathrm{n}}\psi_{\mathrm{n}}(\mathbf{R})$$

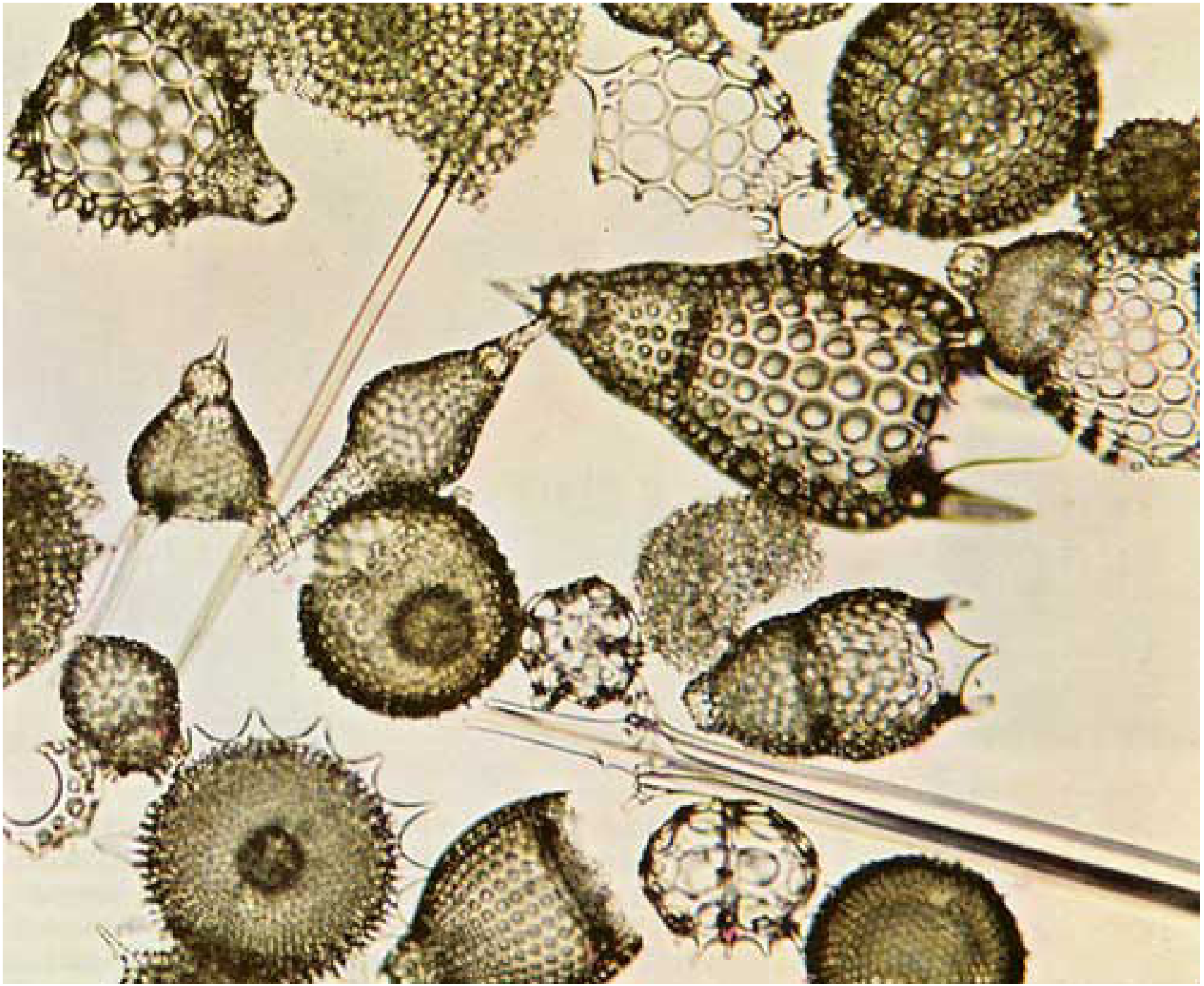
- $2H_2+O_2=2H_2O$

Space shuttle Atlantis
Photograph courtesy NASA

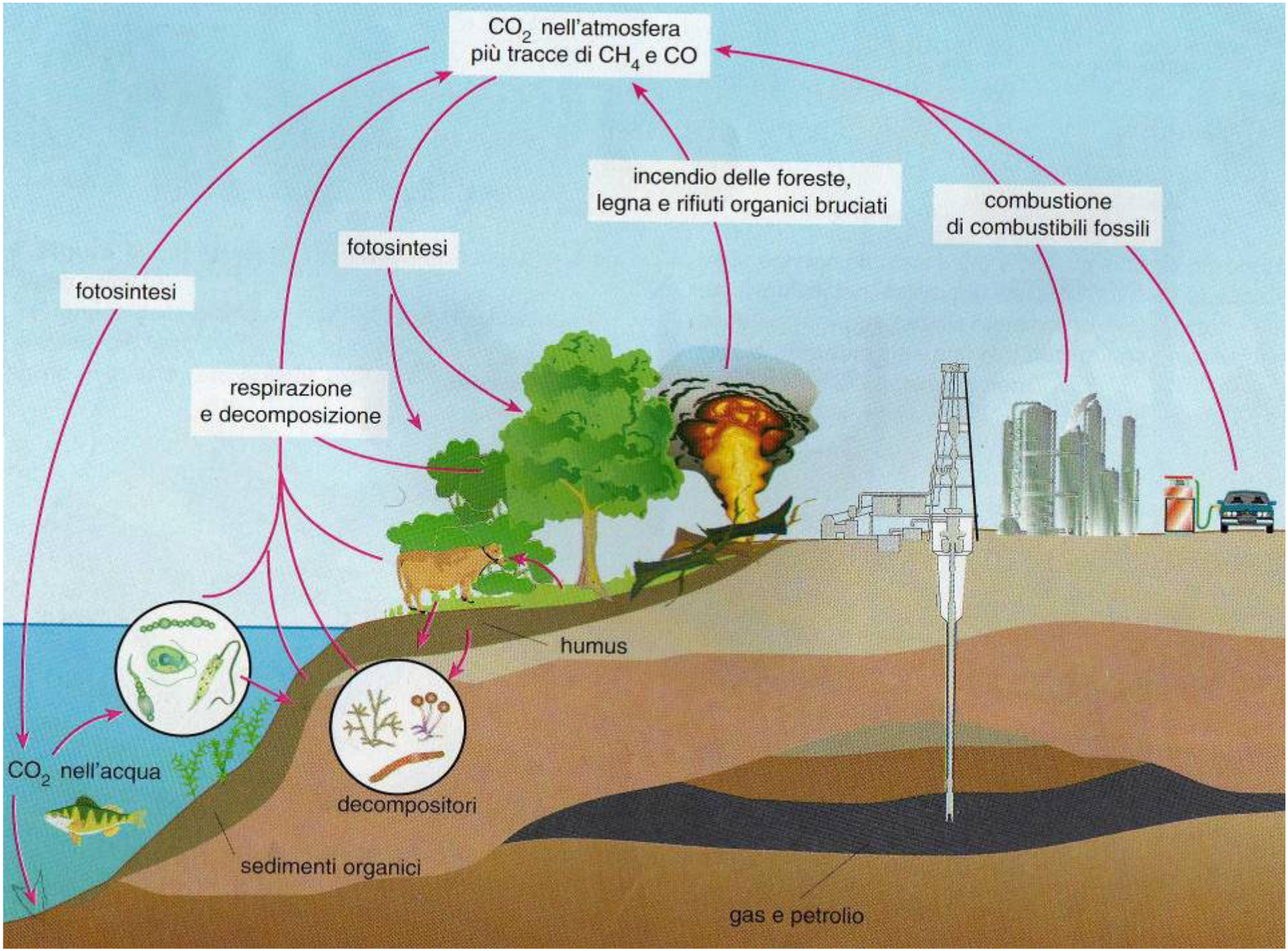
NATIONAL GEOGRAPHIC

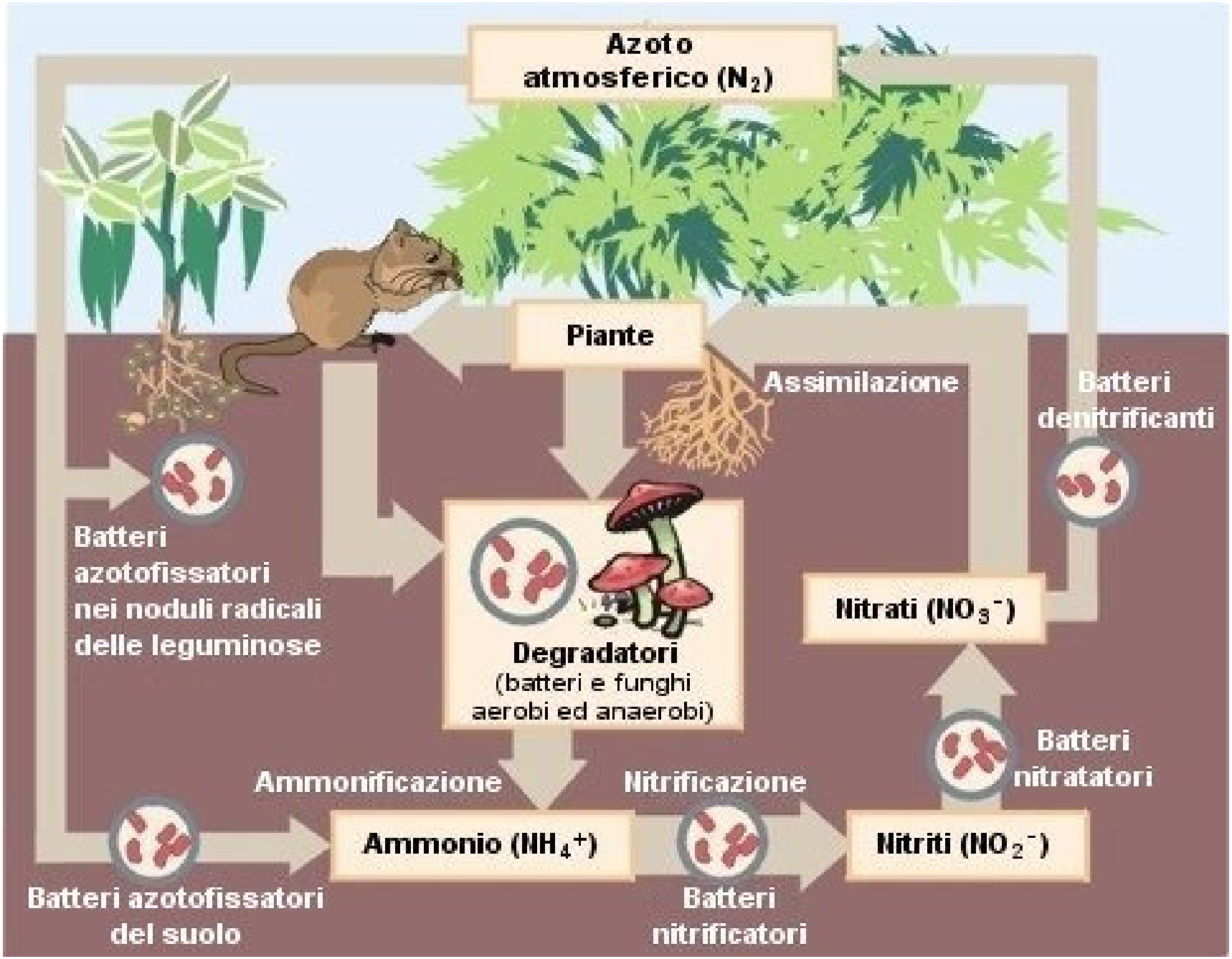
- Caratteristiche dell’ossigeno
- Altamente elettronegativo

- Chimica inorganica con una miriade di composti a bassa capacita’ di trasformazione e
-

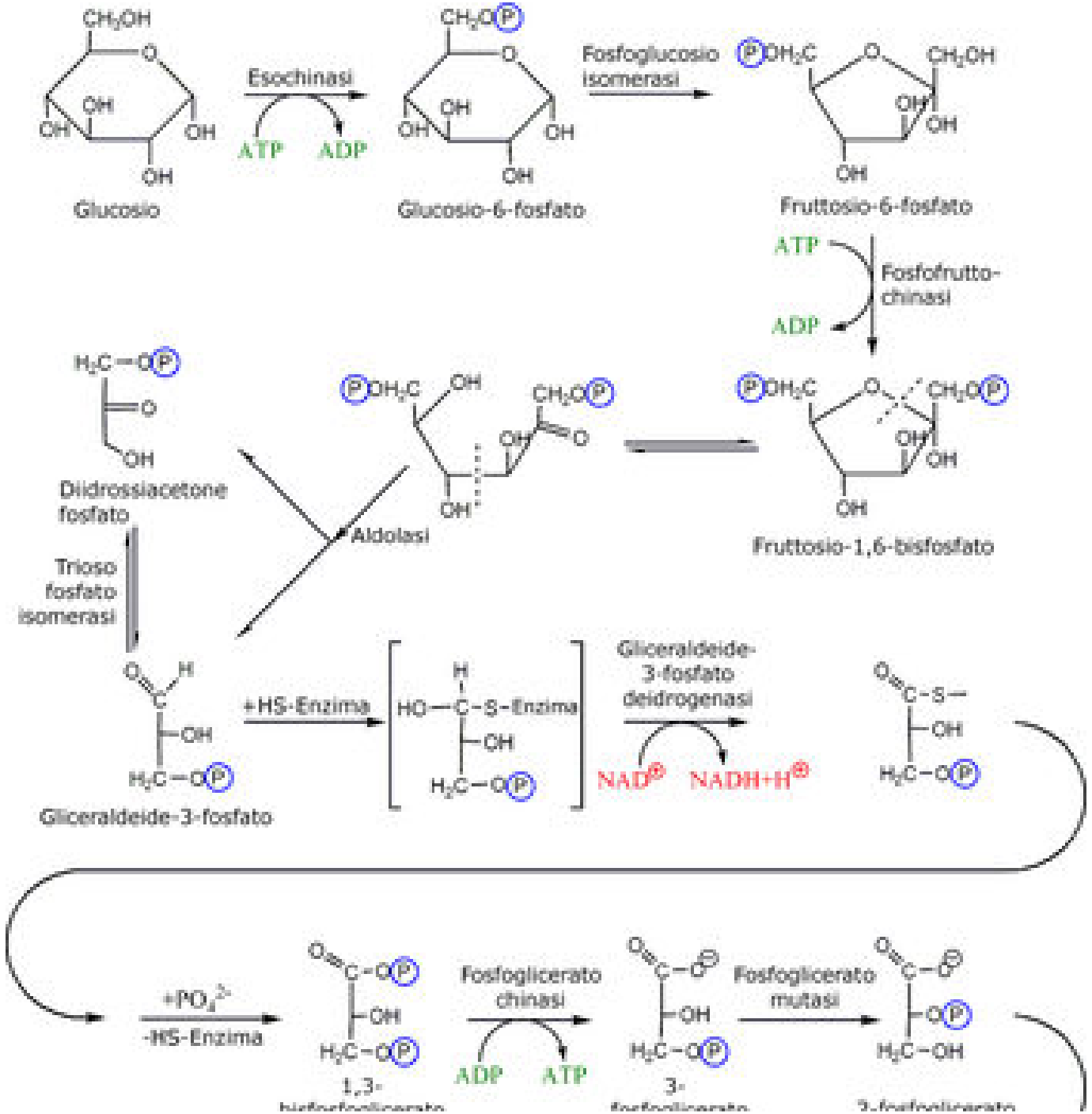


- il carbonio con 4 legami ha avuto un enorme successo sulla Terra, perché??
- Forma polimeri e questi si chiamano macromolecole che derivano dalla trasformazione dell’energia solare.

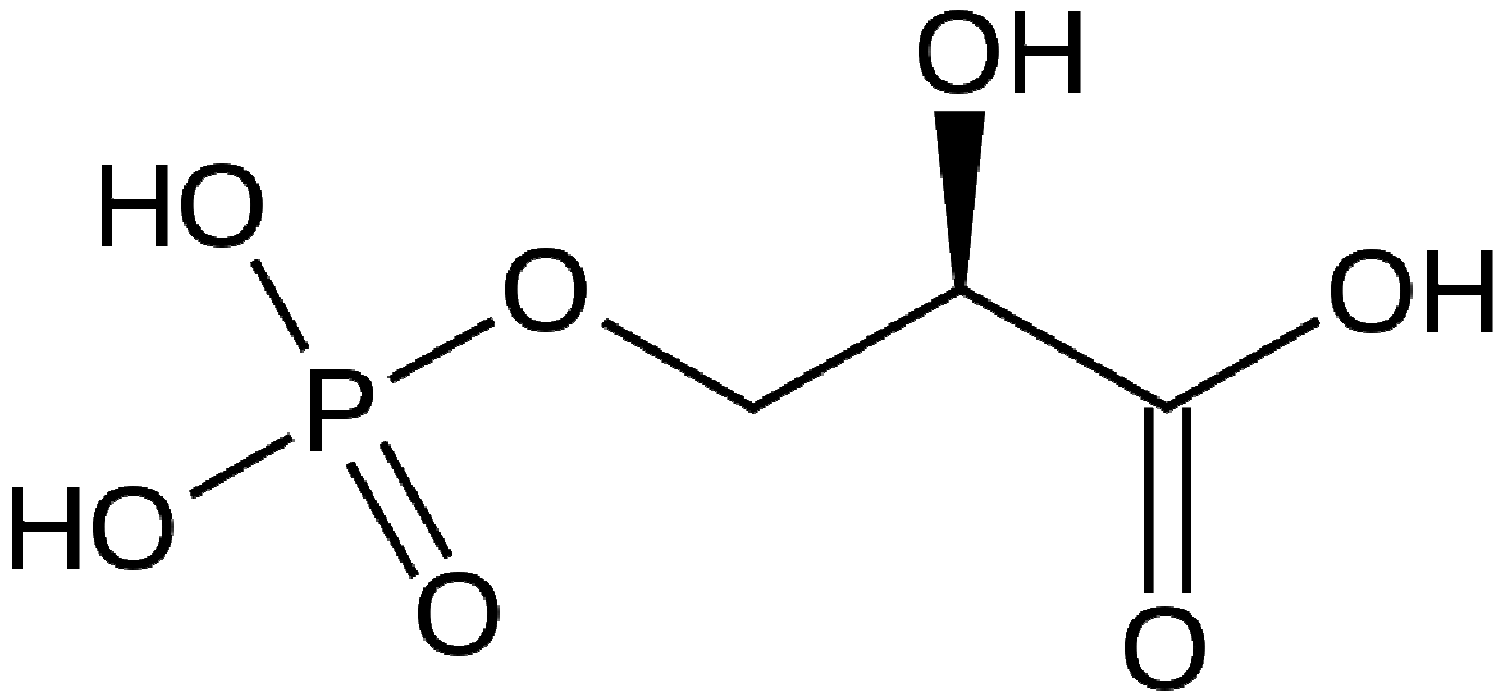

CO_2 nell'atmosfera
più tracce di CH_4 e CO
incendio delle foreste,
legna e rifiuti organici bruciati
combustione
di combustibili fossili
fotosintesi
fotosintesi
respirazione
e decomposizione
humus
CO_2 nell'acqua
decompositori
sedimenti organici
gas e petrolio

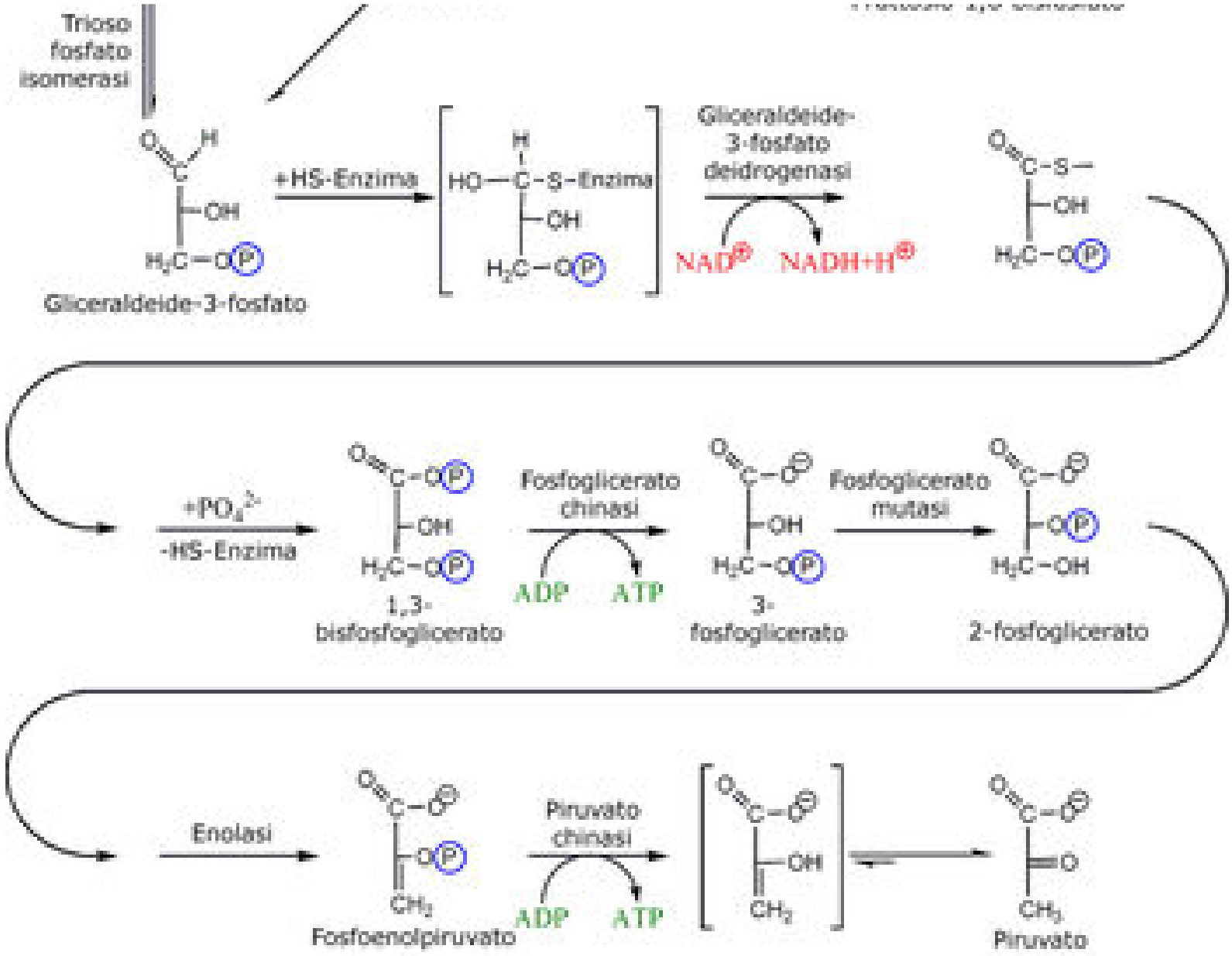

Azoto atmosferico (N_2)
Piante
Assimilazione
Batteri denitrificanti
Batteri azotofissatori nei noduli radicali delle leguminose
Degradatori
(batteri e funghi aerobi ed anaerobi)
Nitrati (NO_3^-)
Batteri nitratatori
Ammonificazione
Nitrificazione
Ammonio (NH_4^+)
Nitriti (NO_2^-)
Batteri azotofissatori del suolo
Batteri nitrificatori

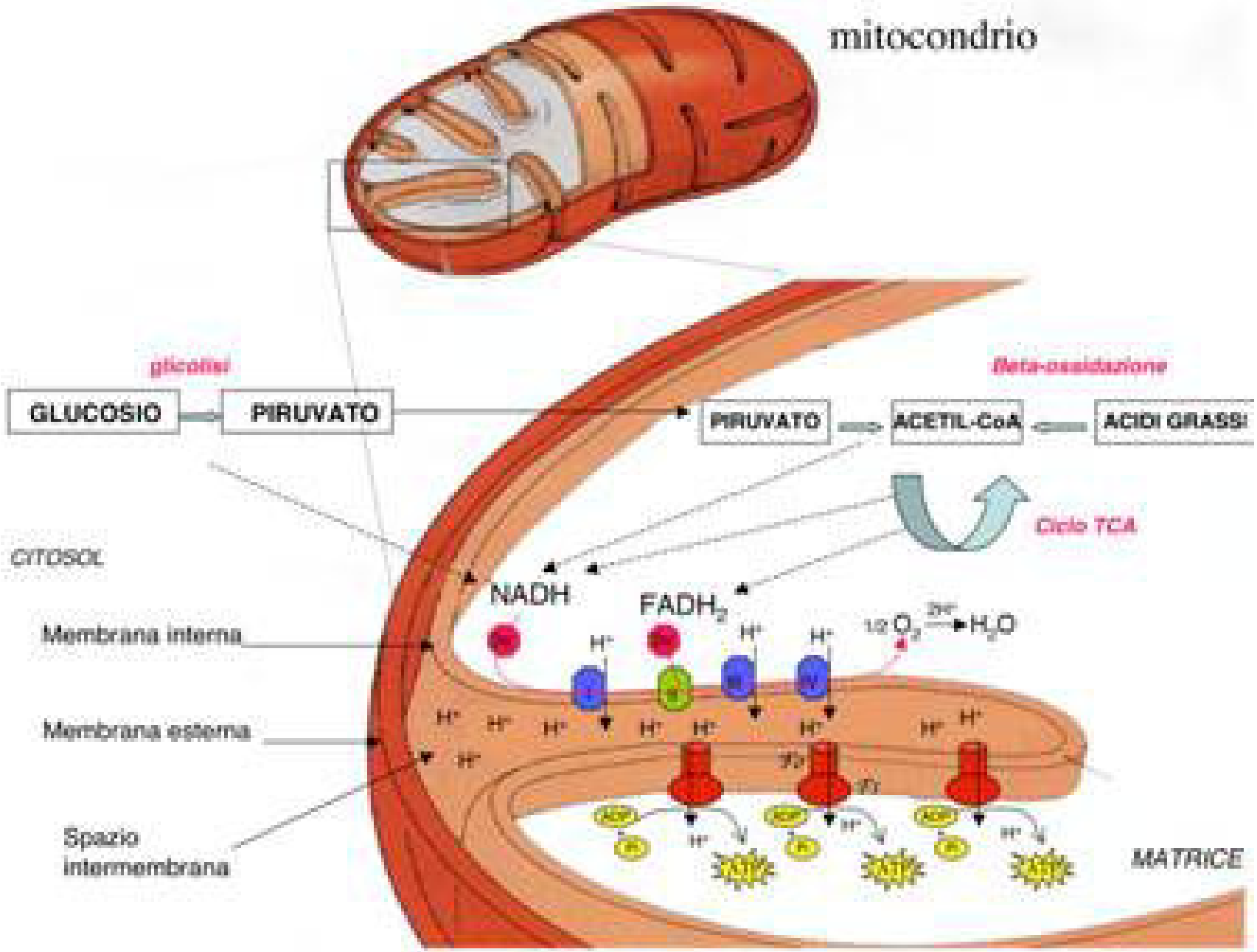
- Glucosio + 6O2= 6CO2 +6H2O +684 Kcal/mol

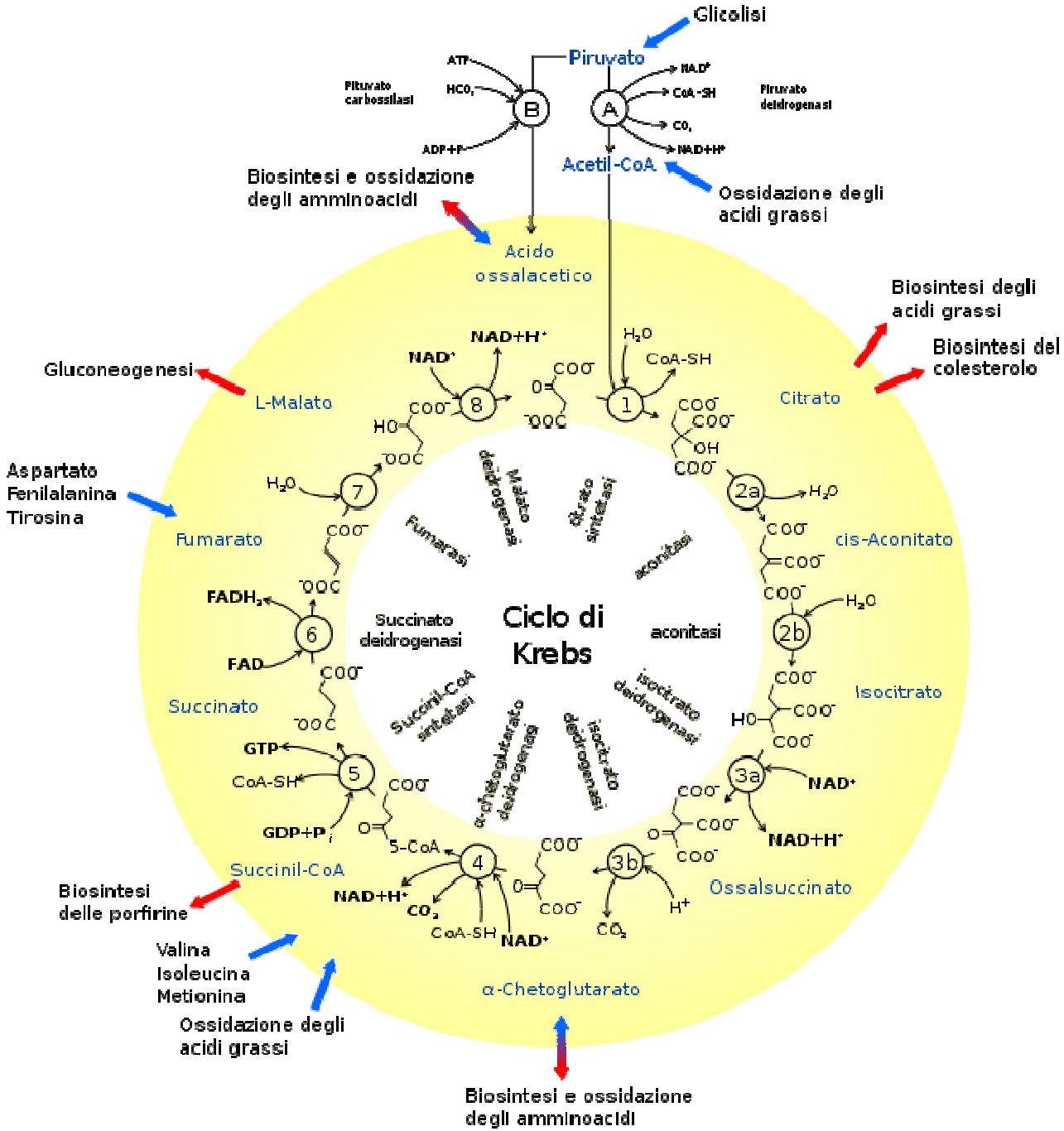

Glucosio
Esochinasi
ATP
ADP
Glucosio-6-fosfato
Fosfoglucosio isomerasi
Fruttosio-6-fosfato
ATP
ADP
Fosfofrutto-chinasi
Fruttosio-1,6-bisfosfato
Aldolasi
Diidrossiacetone fosfato
Trioso fosfato isomerasi
Gliceraldeide-3-fosfato
+HS-Enzima
Gliceraldeide-3-fosfato deidrogenasi
NAD⊕
NADH+H⊕
+PO4 2-
-HS-Enzima
1,3-
Fosfoglicerato chinasi
ADP
ATP
3-
Fosfoglicerato mutasi
3-fosfoglicerato

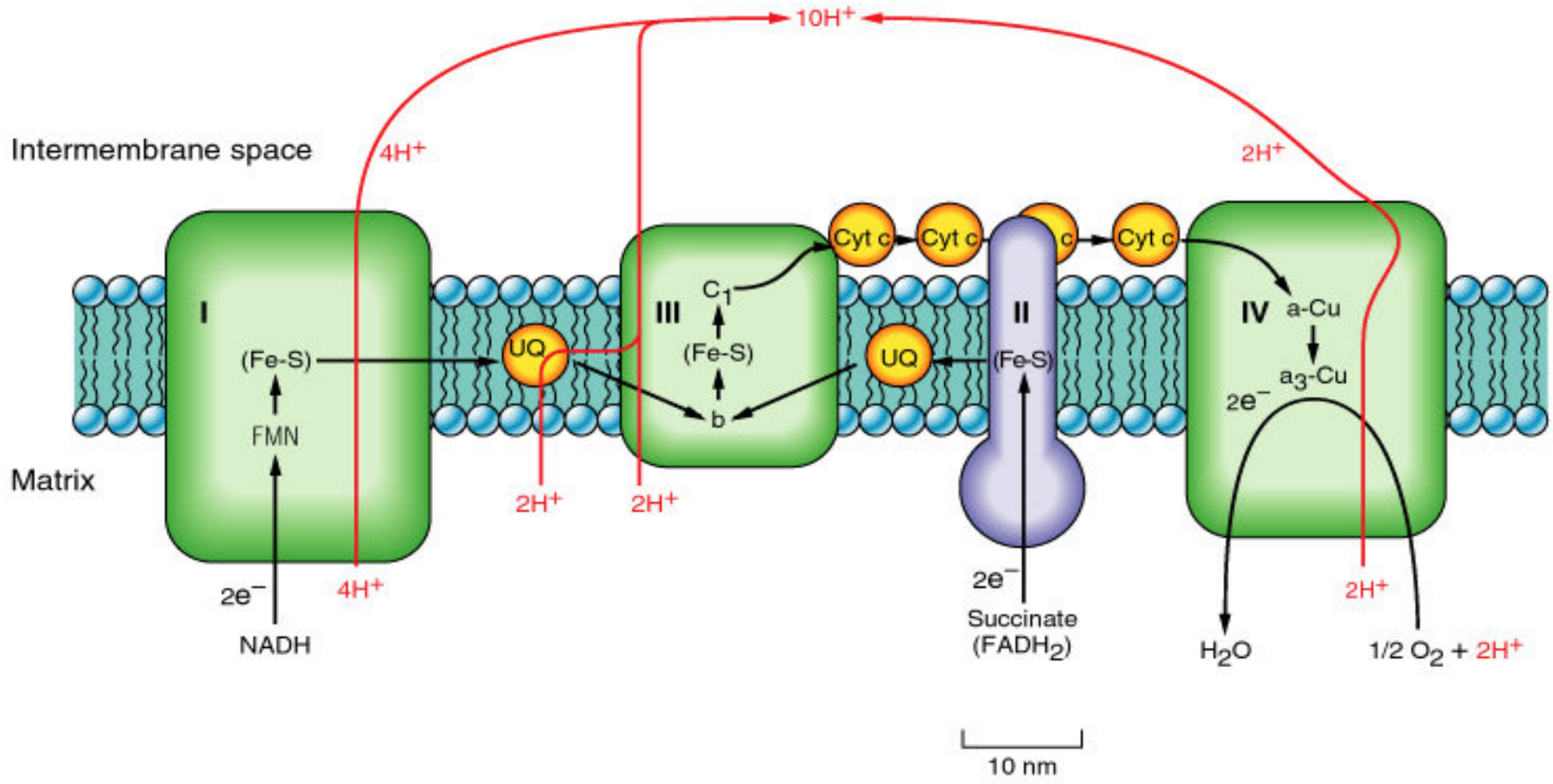
Acido 3 fosfoglicerico



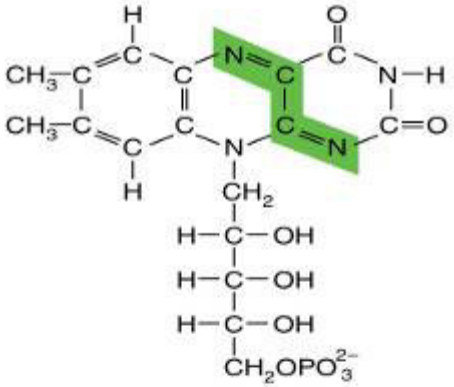

Triosofosfato isomerasi
Gliceraldeide-3-fosfato
+HS-Enzima
Gliceraldeide-3-fosfato deidrogenasi
NAD⊕
NADH+H⊕
+PO4 2-
-HS-Enzima
1,3-bisfosfoglicerato
Fosfoglicerato chinasi
ADP
ATP
3-fosfoglicerato
Fosfoglicerato mutasi
2-fosfoglicerato
Enolasi
Fosfoenolpiruvato
Piruvato chinasi
ADP
ATP
Piruvato


mitocondrio
glicolisi
GLUCOSIO
PIRUVATO
PIRUVATO
ACETIL-CoA
ACIDI GRASSI
beta-ossidazione
Ciclo TCA
CITOSOL
NADH
FADH2
Membrana interna
Membrana esterna
Spazio intermembrana
MATRICE


Glicolisi
Piruvato
ATP
HCO3
ADP+P
Piruvato carbossilasi
B
A
NAD+
CoA-SH
CO2
NADH+H+
Piruvato deidrogenasi
Acetil-CoA
Biosintesi e ossidazione degli amminoacidi
Ossidazione degli acidi grassi
Acido ossalacetico
Biosintesi degli acidi grassi
Biosintesi del colesterolo
Gluconeogenesi
L-Malato
Citrato
Aspartato
Fenilalanina
Tirosina
Fumarato
cis-Aconitato
Isocitrato
Succinato
Succinil-CoA
Ossalsuccinato
α-Chetoglutarato
Biosintesi delle porfirine
Valina
Isoleucina
Metionina
Ossidazione degli acidi grassi
Biosintesi e ossidazione degli amminoacidi
Ciclo di Krebs
Malato deidrogenasi
Citrato sintetasi
Fumarasi
aconitasi
Succinato deidrogenasi
aconitasi
Succinil-CoA sintetasi
Isocitrato deidrogenasi
α-chetoglutarato deidrogenasi
Isocitrato deidrogenasi
1
2a
2b
3a
3b
4
5
6
7
8
H2O
CoA-SH
NAD+
NADH+H+
FADH2
FAD
GTP
GDP+Pi
CO2
H+

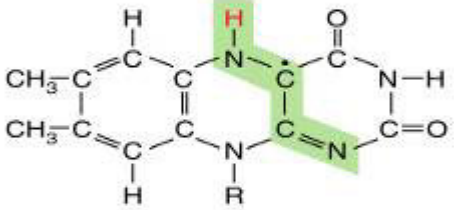


SUBUNITS	Complex I NADH Dehydrogenase Mammalian	Complex III Cytochrome bc_1	Complex II Succinate dehydrogenase	Complex IV Cytochrome *c* Oxidase
mtDNA	7	1	0	3
nDNA	35	10	4	10
TOTAL	42	11	4	13



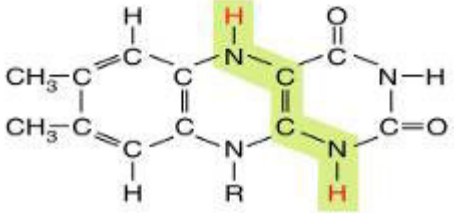
Oxidized form of FMN
(quinone state)

$-H^+ - e^-$ ⇌ $+H^+ + e^-$



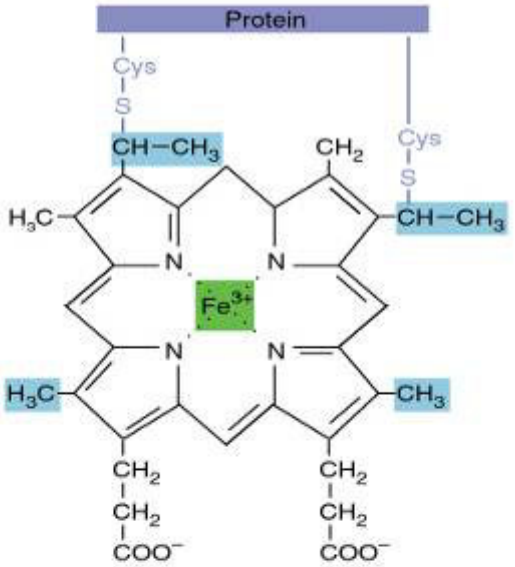
Intermediate free radical
(semiquinone state)

$-H^+ - e^-$ ⇌ $+H^+ + e^-$



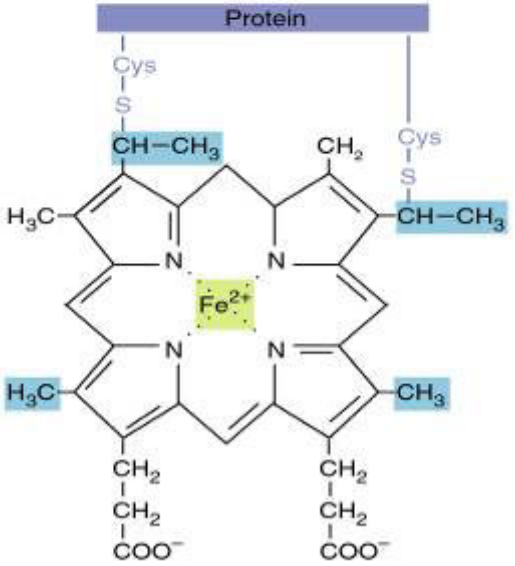
Reduced form of FMN
(hydroquinone state)

(a)

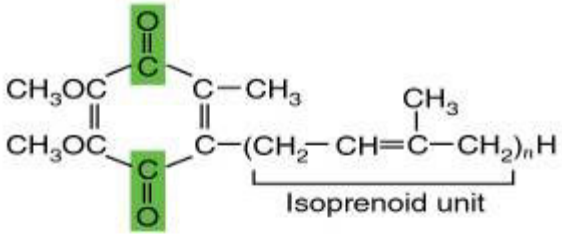


Oxidized form of Heme

$-1e^-$ ⇌ $+1e^-$

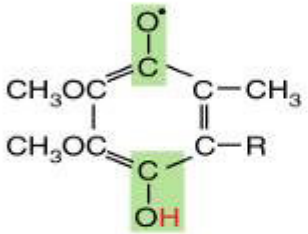


(b) Reduced form of Heme



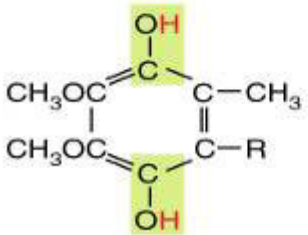
Oxidized form of Ubiquinone
(quinone state)

$-H^+ - e^-$ ⇌ $+H^+ + e^-$



Intermediate free radical
(ubisemiquinone)

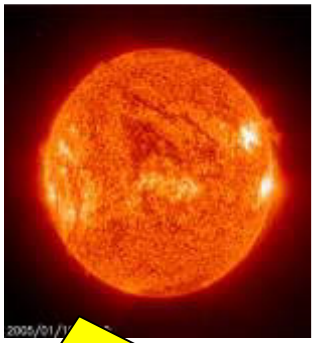
$-H^+ - e^-$ ⇌ $+H^+ + e^-$



Reduced form of Ubiquinone
(ubiquinol)

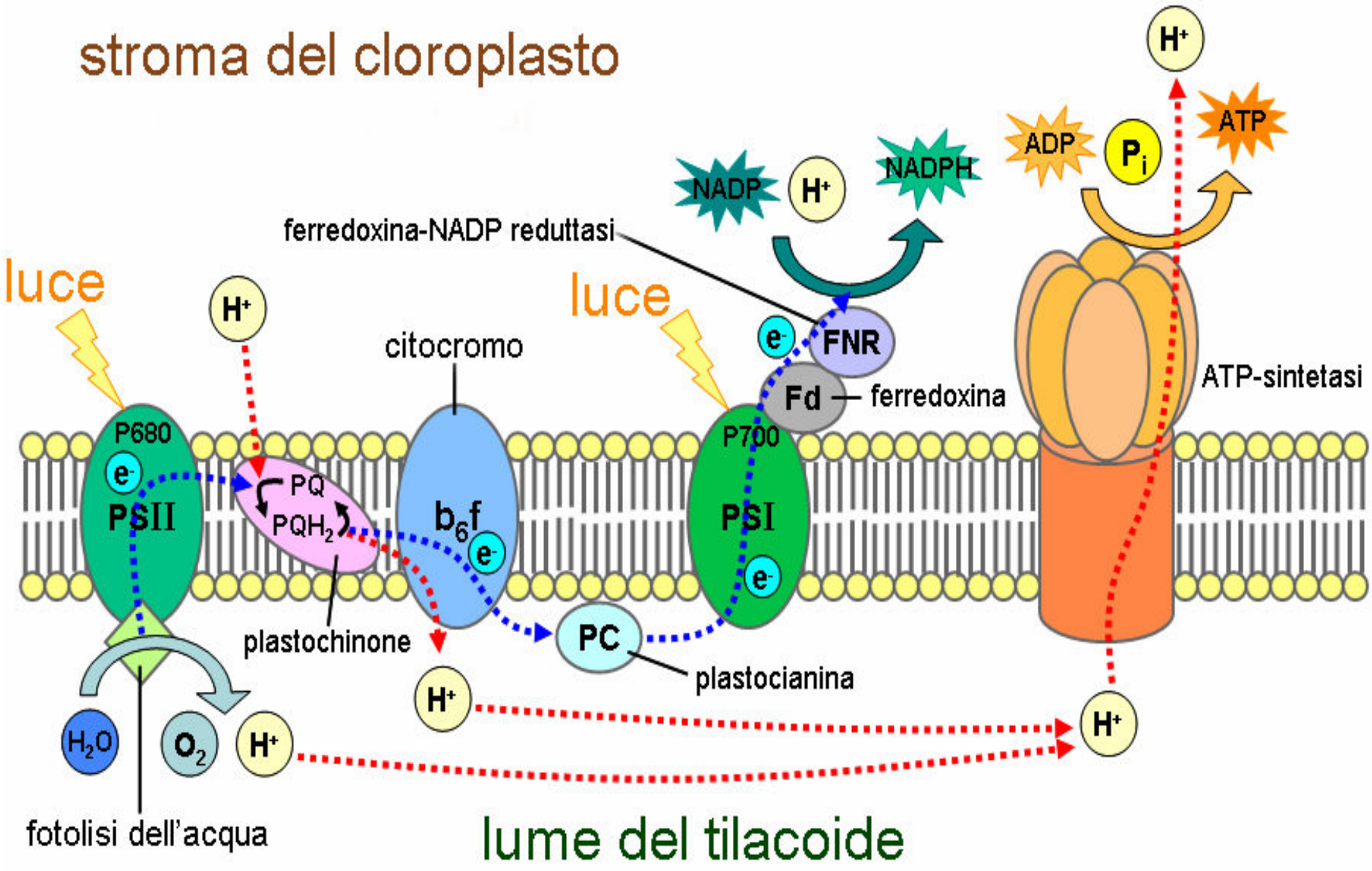
(c)

Fotosintesi

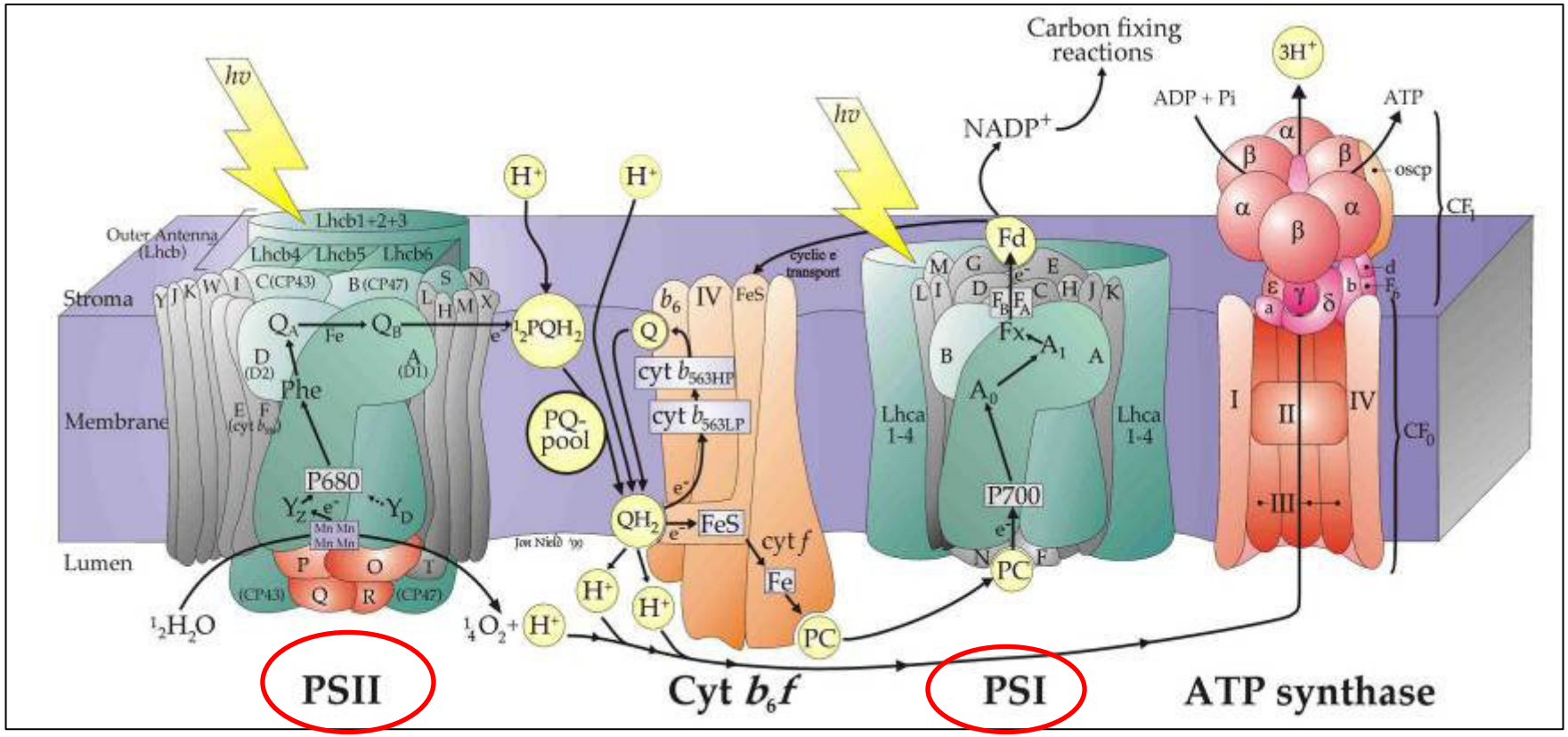


$CO_2 + H_2O + E =$

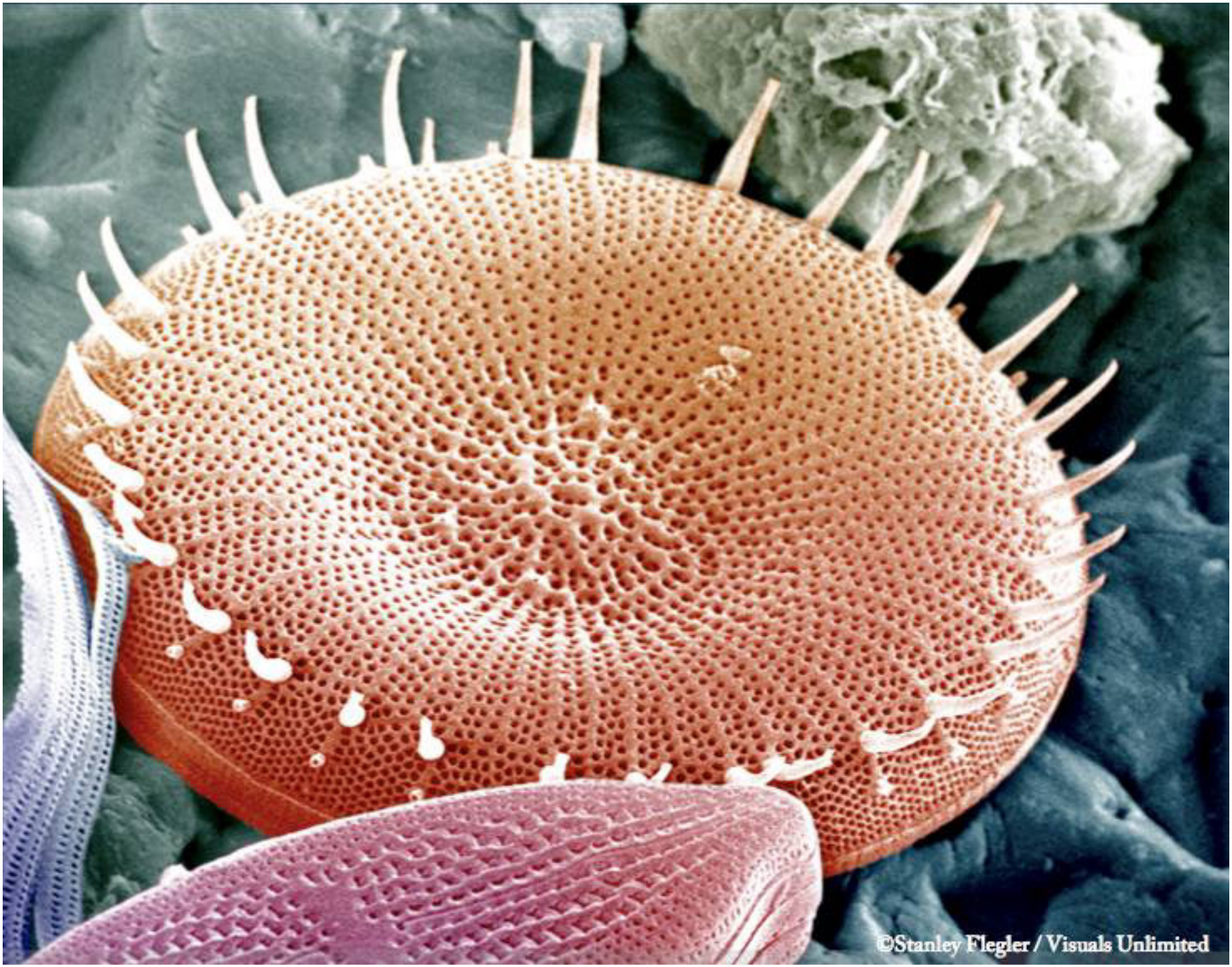
zuccheri $+ O_2$


stroma del cloroplasto
luce
H+
P680
e-
PSII
PQ
PQH2
plastochinone
citocromo
b6f
e-
luce
P700
PSI
e-
ferredoxina-NADP reduttasi
NADP
H+
NADPH
e-
FNR
Fd
ferredoxina
PC
plastocianina
ADP
Pi
ATP
ATP-sintetasi
H+
H+
H+
H+
H2O
O2
fotolisi dell'acqua
lume del tilacoide

Fotosintesi e fotoprotezione nelle piante e nelle alghe



- fotosistema I (PSI) and fotosistema II (PSII)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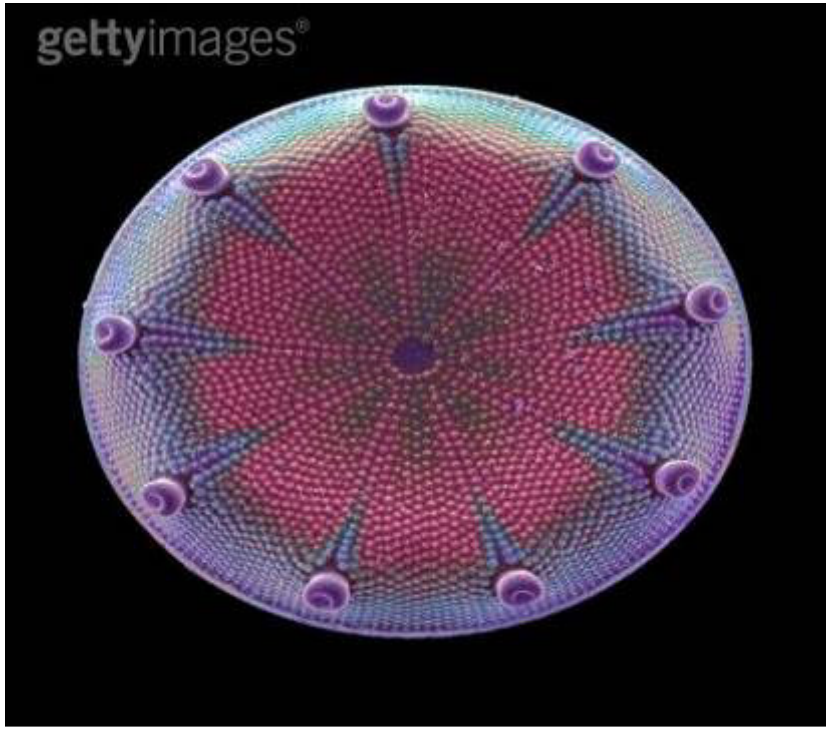
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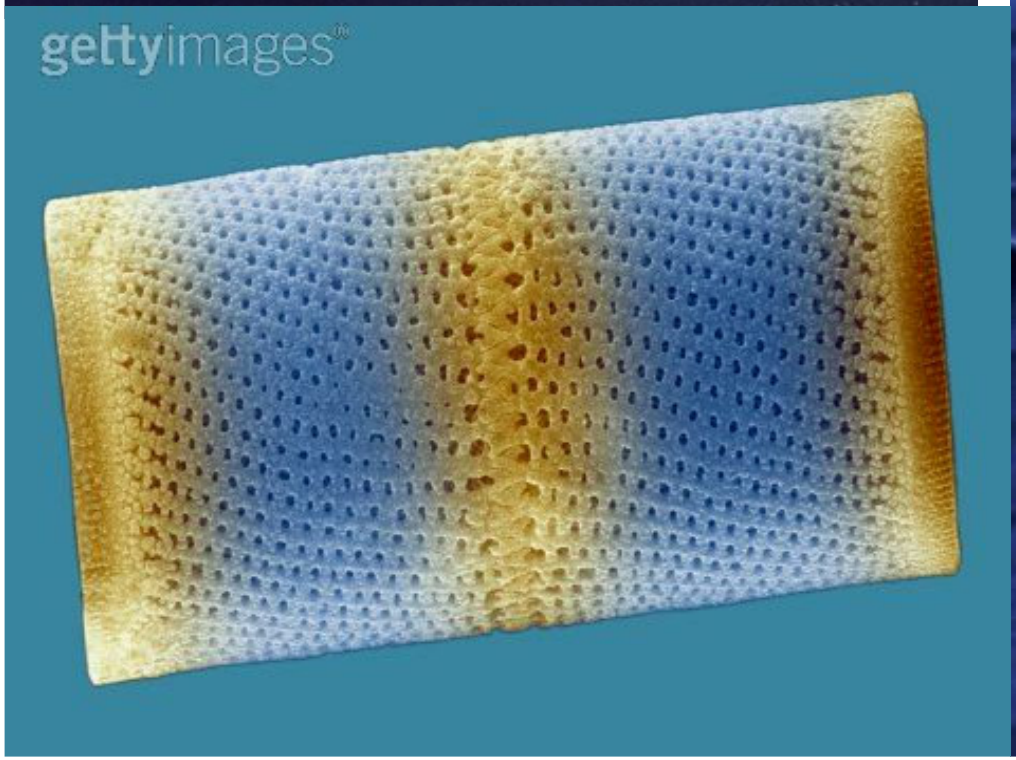
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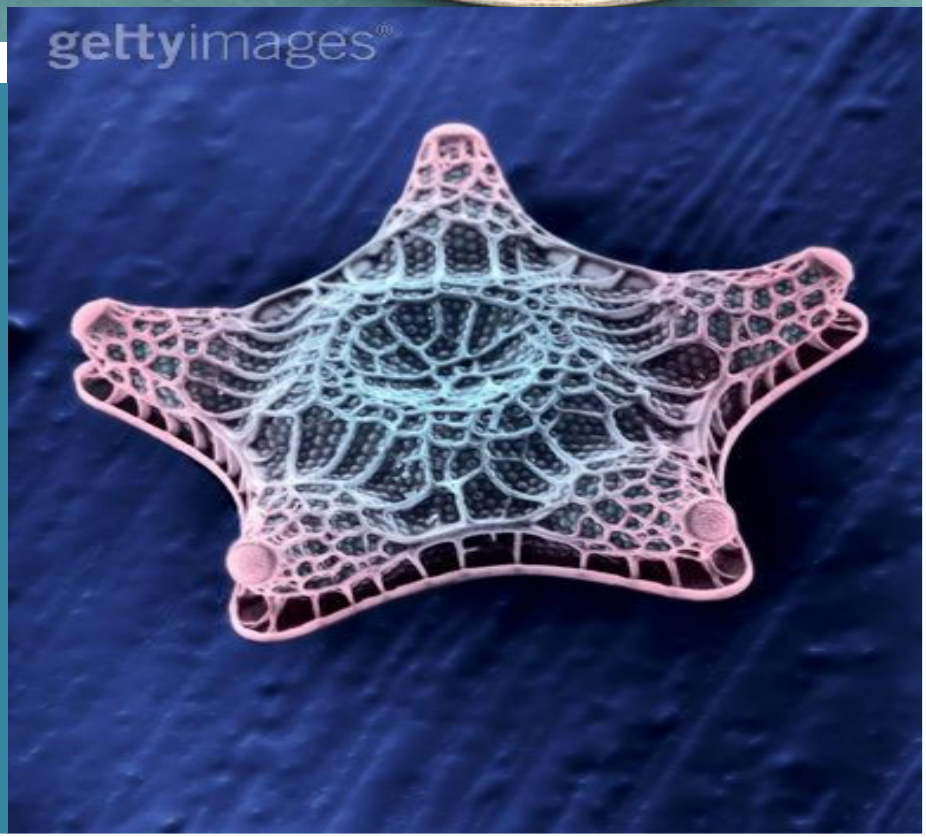
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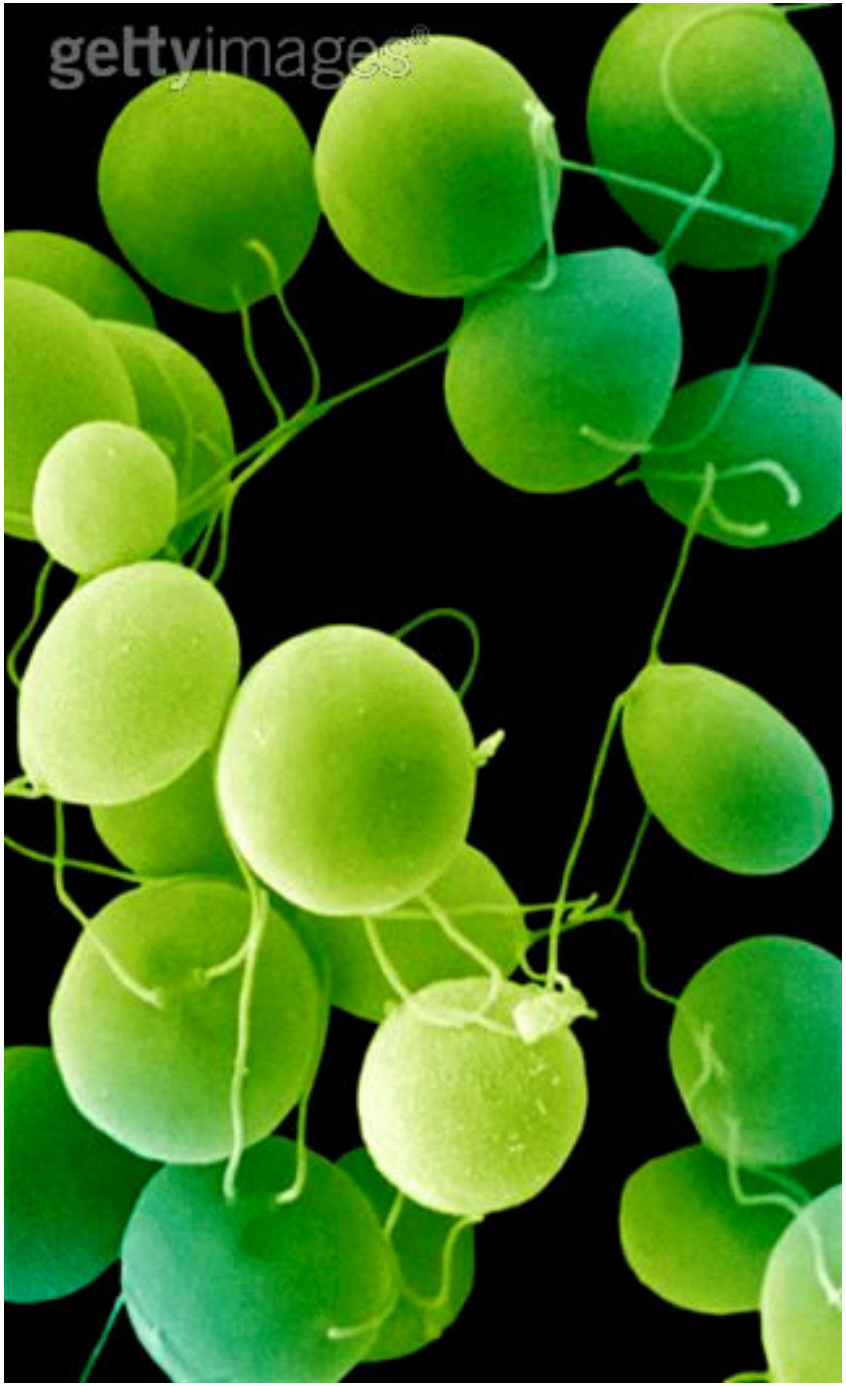
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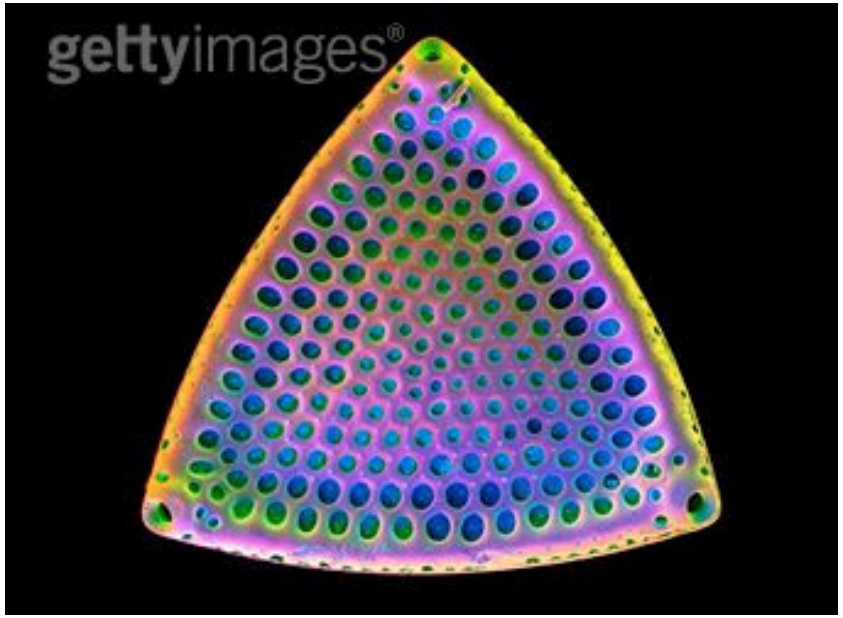
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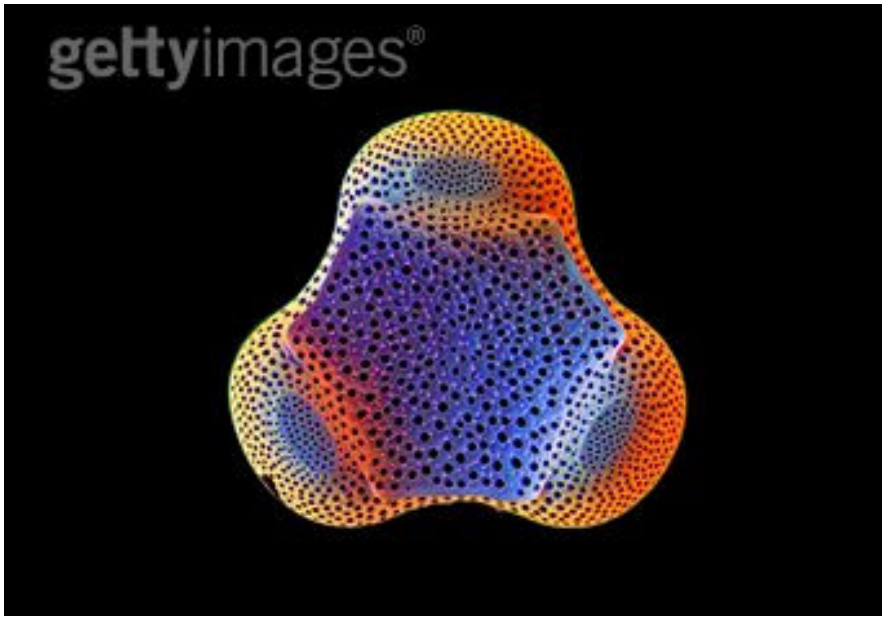
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Come produrre idrogeno

Energia elettrica

$$2H_2O+E=2H_2+O_2$$

Quanta energia occorre per produrre l'idrogeno da utilizzare in Italia?

Space shuttle Atlantis
Photograph courtesy NASA

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