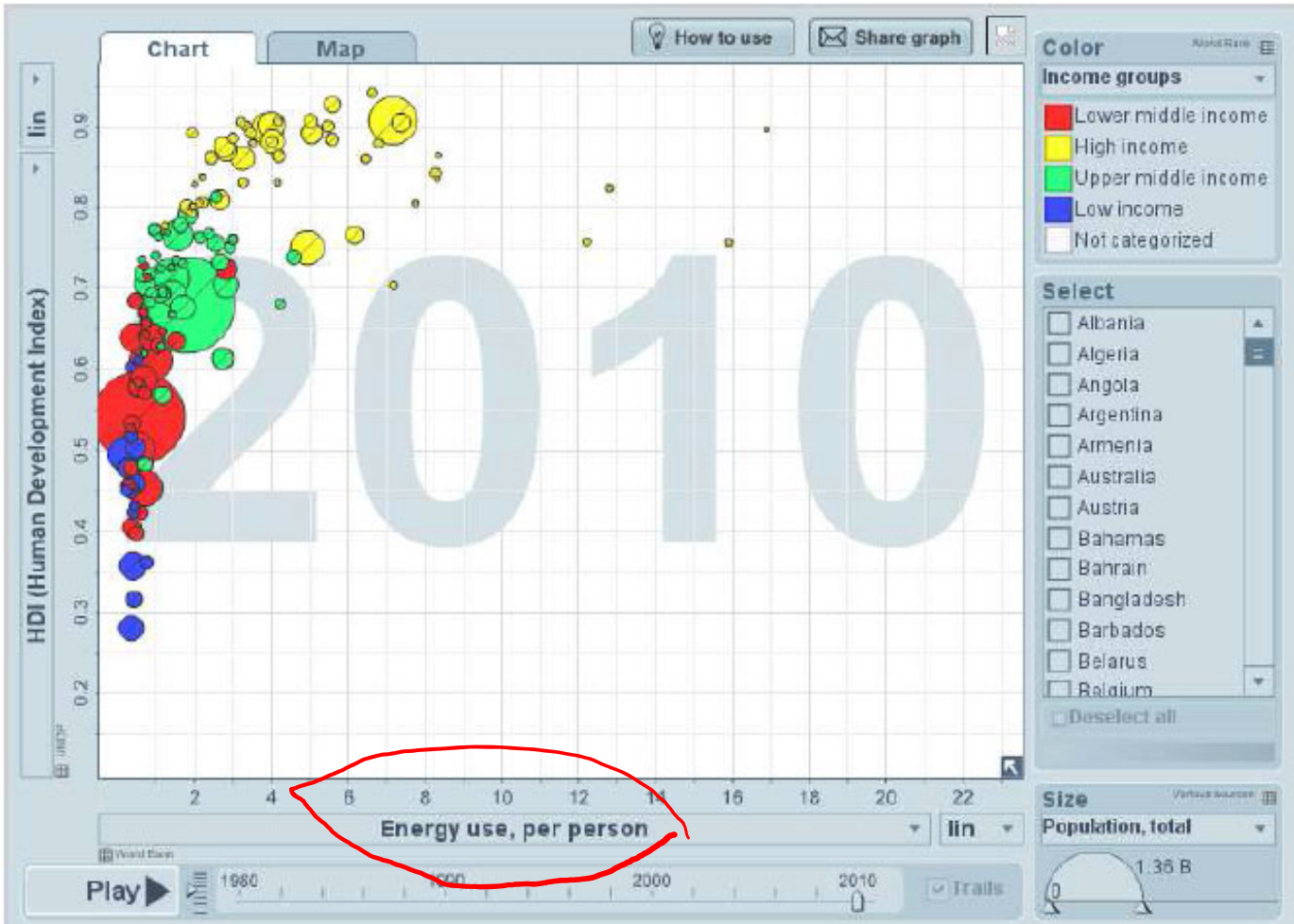
Appreciating O_2

- Oxygen is a diradical held by weak bonds (BDE = 498 kJ/mol)
- Contrast to H_2 (872 kJ/mol)

Energy is required for all activities – ecological and industrial – a universal currency

Energy is critical to Human well-being



Sources of Energy

Fossil Fuels???

$$CH_4 + O_2 \longrightarrow CO_2 + H_2O$$

Carbohydrates???

$$H_2 + O_2 \longrightarrow H_2O$$

$H_2 + O_2 \rightarrow H_2O \Rightarrow -460\ kJ/mol$

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

$2C_8H_{18} + 25O_2 \longrightarrow CO_2 + 2H_2O$

C_2H_5OH

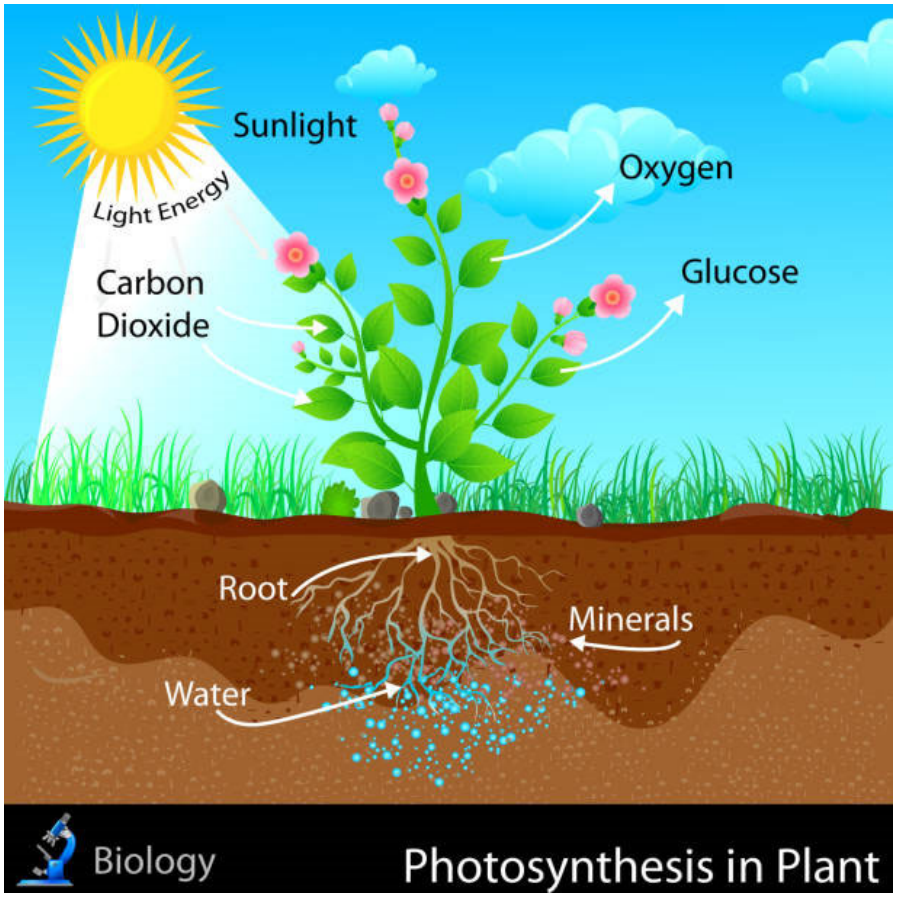
Sucrose

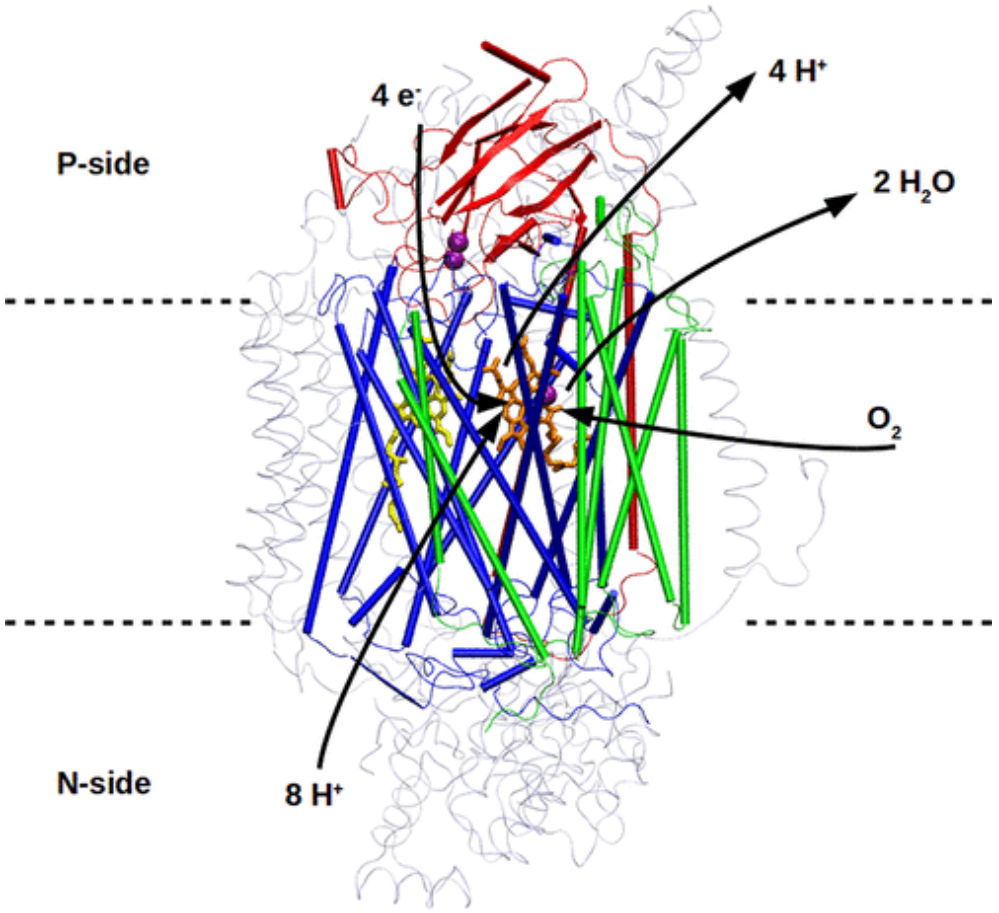
	ΔH (exp) (kJ/mol)	Moles of O_2	ΔH (calc) (kJ/mol)
CH_4	-890	2	2x-460 = -920
C_8H_{18}	-5452	12.5	12.5x-460 = -5750
C_2H_5OH	-1367	3	-1380
sucrose	-5520	12	-5644

- Combustion of any "fuel" is very favorable due to the exothermic nature of the reaction (~460 kJ/mol of O_2) leading to the formation of water

O_2 Production and Utilization in Nature

$H_2O \rightarrow H_2 + O_2$





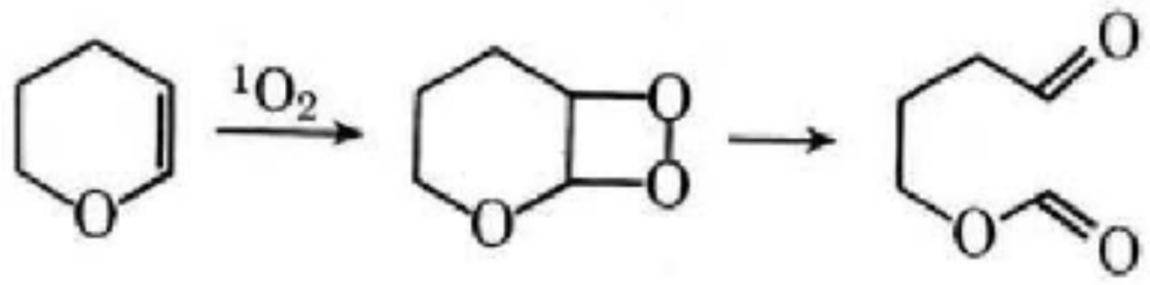
Coupled to production of ATP

Reactivity of O_2

- Why doesn't O_2 react spontaneously?
- Triplet and Singlet O_2

Triplet + singlet reaction
⇓
Spin-forbidden
Excited state ⇒ O_2 in sight

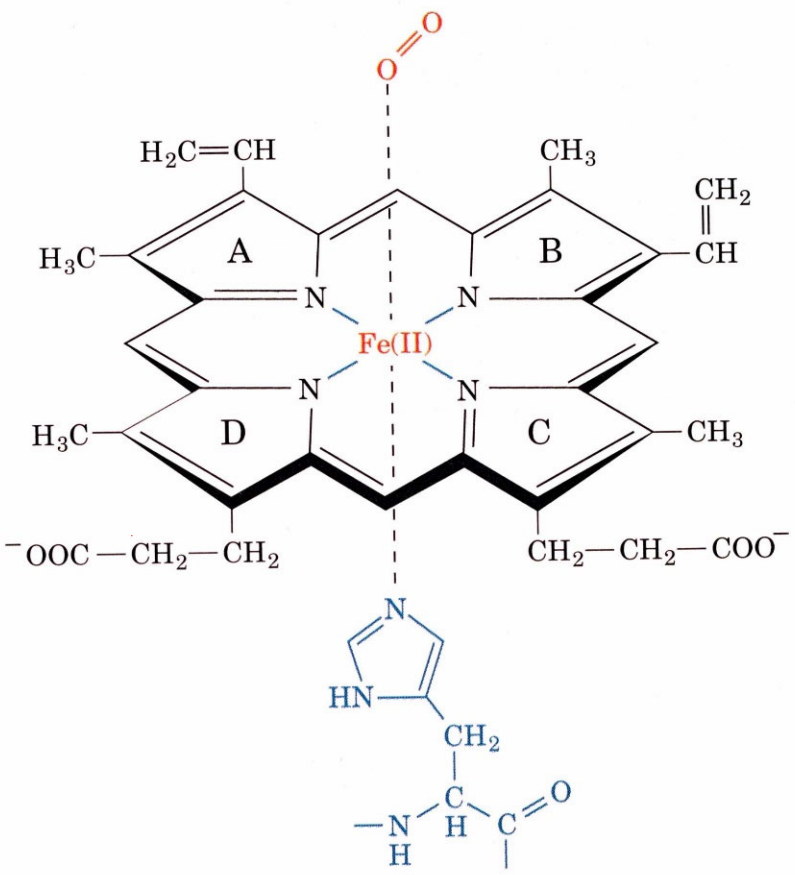
O_2 ⇒ Triplet
Hydrocarbons } Singlet
H_2

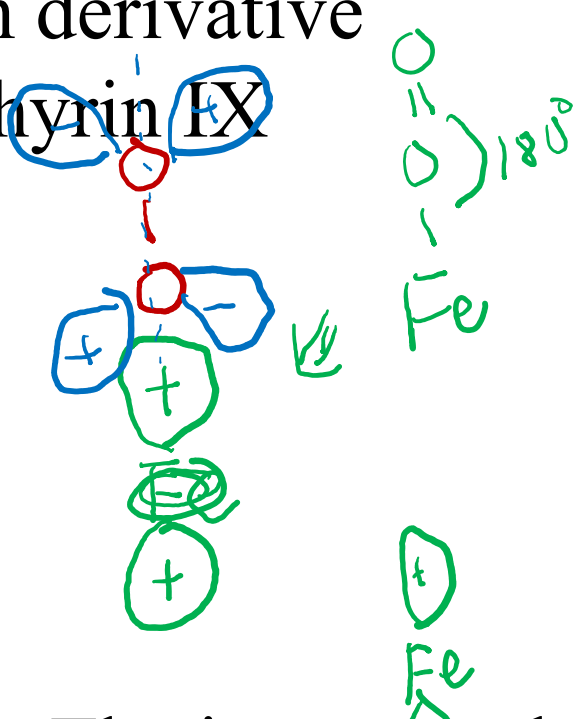


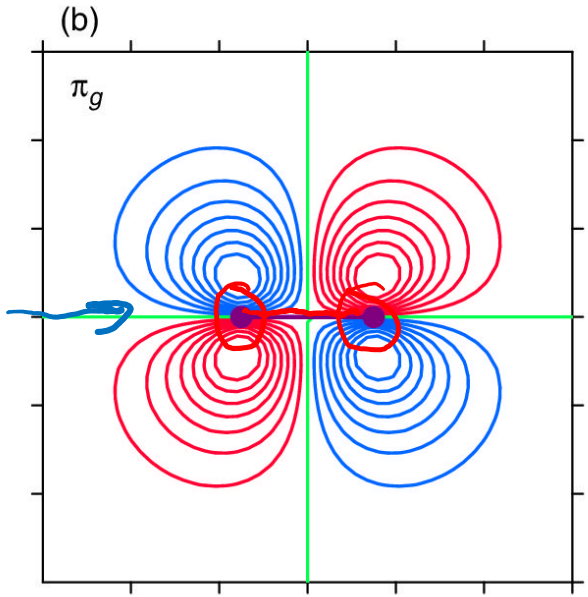
O_2 binding to Heme group

Each subunit of hemoglobin or myoglobin contains a heme.

- Binds one molecule of oxygen
- Heterocyclic porphyrin derivative
- Specifically protoporphyrin IX







The iron must be in the Fe(II) form or reduced form. (ferrous oxidation) state.

Binding of O_2 vs CO