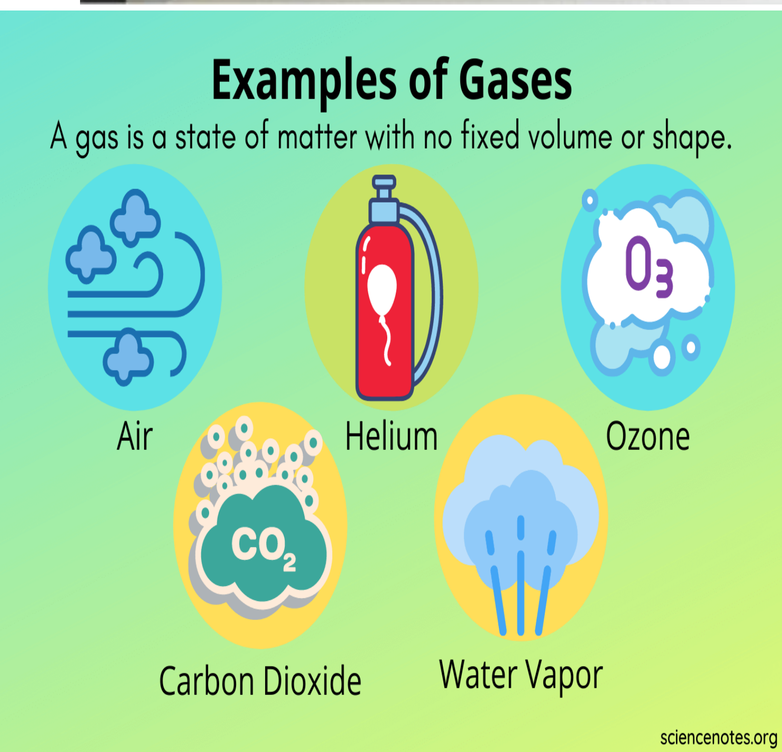
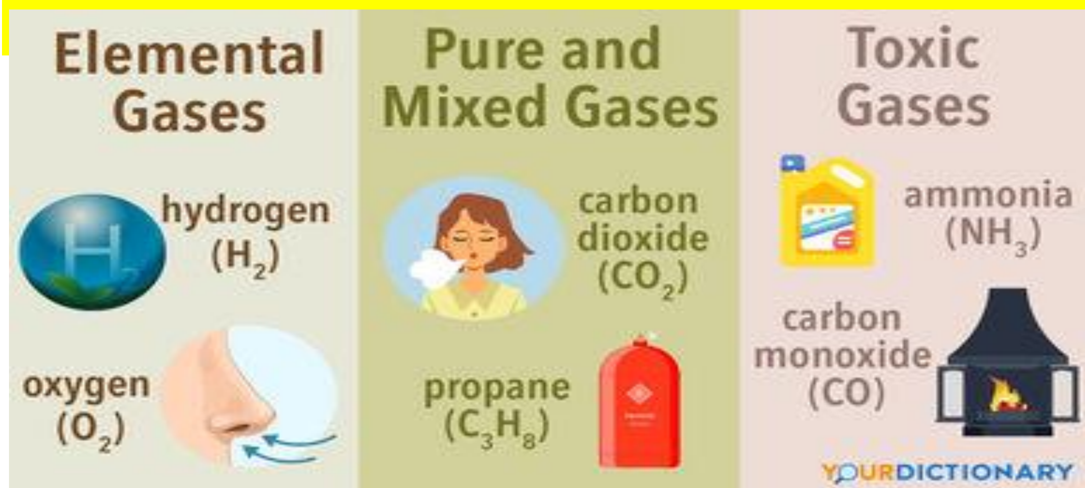
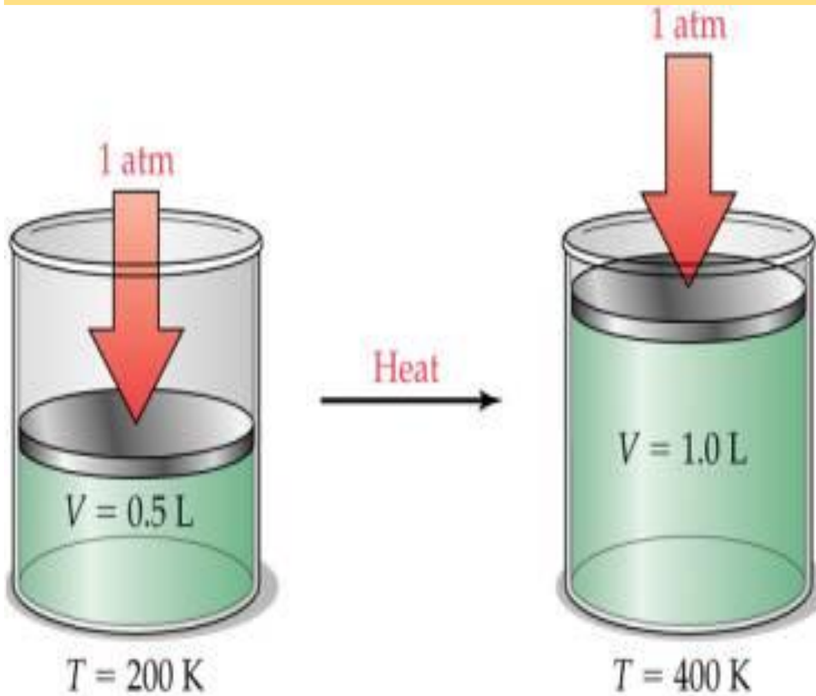
Gasses and Medical Gasses

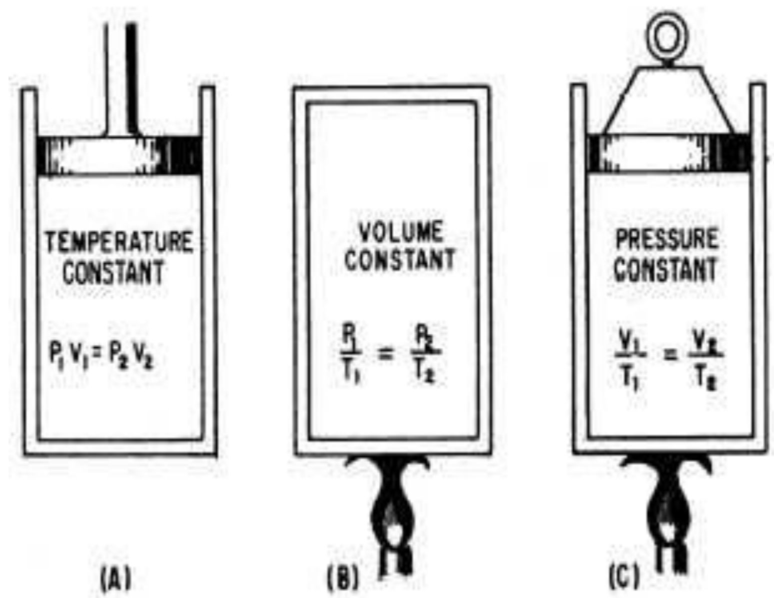




Gasses are simpler for consideration than solids and liquids

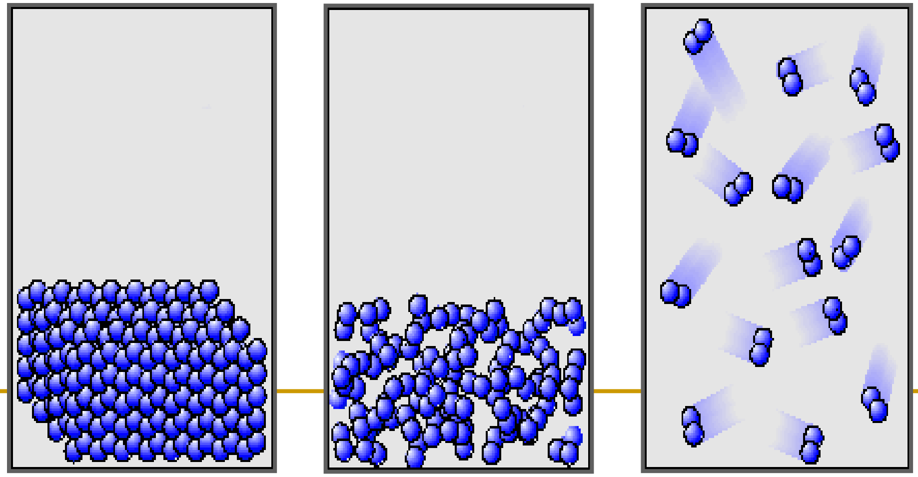
---their properties can be defined by four parameters> Pressure, Volume, Temperature and mass of defined gas





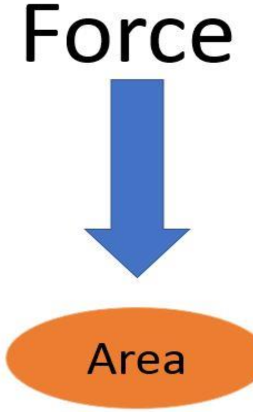
Characteristics of Gases

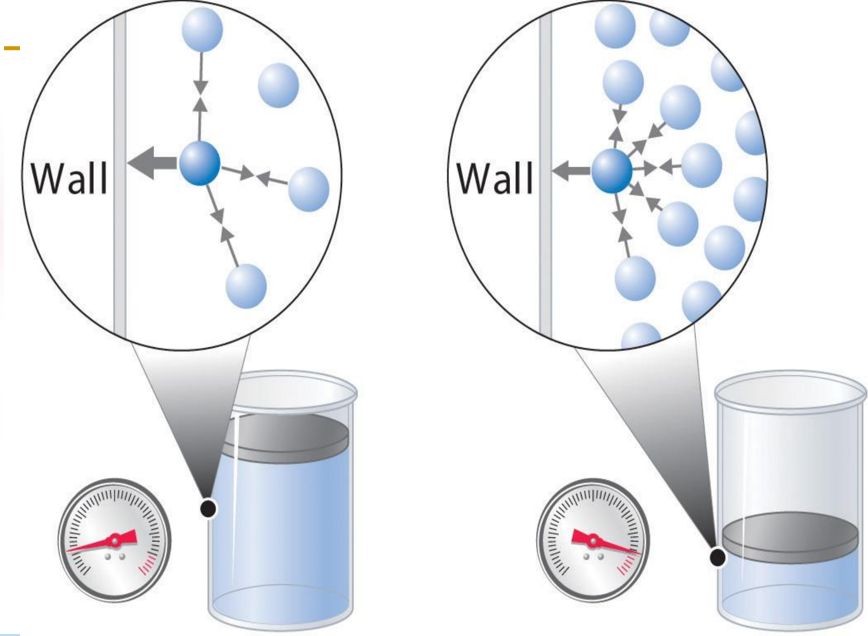
- Gases expand to fill any container.
  - random motion, no attraction
- Gases are fluids (like liquids).
  - no attraction
- Gases have very low densities.
  - no volume = lots of empty space



We breath air…and in the air we have…

Gas	Percentage by Volume	Gas	Percentage by Volume
Nitrogen	78.084	Krypton	0.0001
Oxygen	20.948	Carbon monoxide	0.00001[2]
Argon	0.934	Xenon	0.00008
Carbon dioxide	0.033[1]	Ozone	0.00002[2]
Neon	0.00182	Ammonia	0.00001
Hydrogen	0.0010	Nitrogen dioxide	0.000001[2]
Helium	0.00052	Sulfur dioxide	0.0000002[2]
Methane	0.0002[1]		





(a) Low pressure (b) High pressure

Units of pressure P

Important Units of Pressure

Unit	Relationship or Definition
Pascal (Pa)	$kg/(m \cdot s^2)$
Atmosphere (atm)	$1\ atm = 1.01325 \times 10^5\ Pa \simeq 100\ kPa$
mmHg, or torr	760 mmHg = 1 atm

Important Gas Laws---we gonna see how the volume of given gas is function of other parameters…

1. Boyle's law

- ***At constant temperature, the VOLUME (V) of a given gas is inversely proportional to the applied pressure (P)***

$V \alpha 1/P$

$V = a * 1/P$

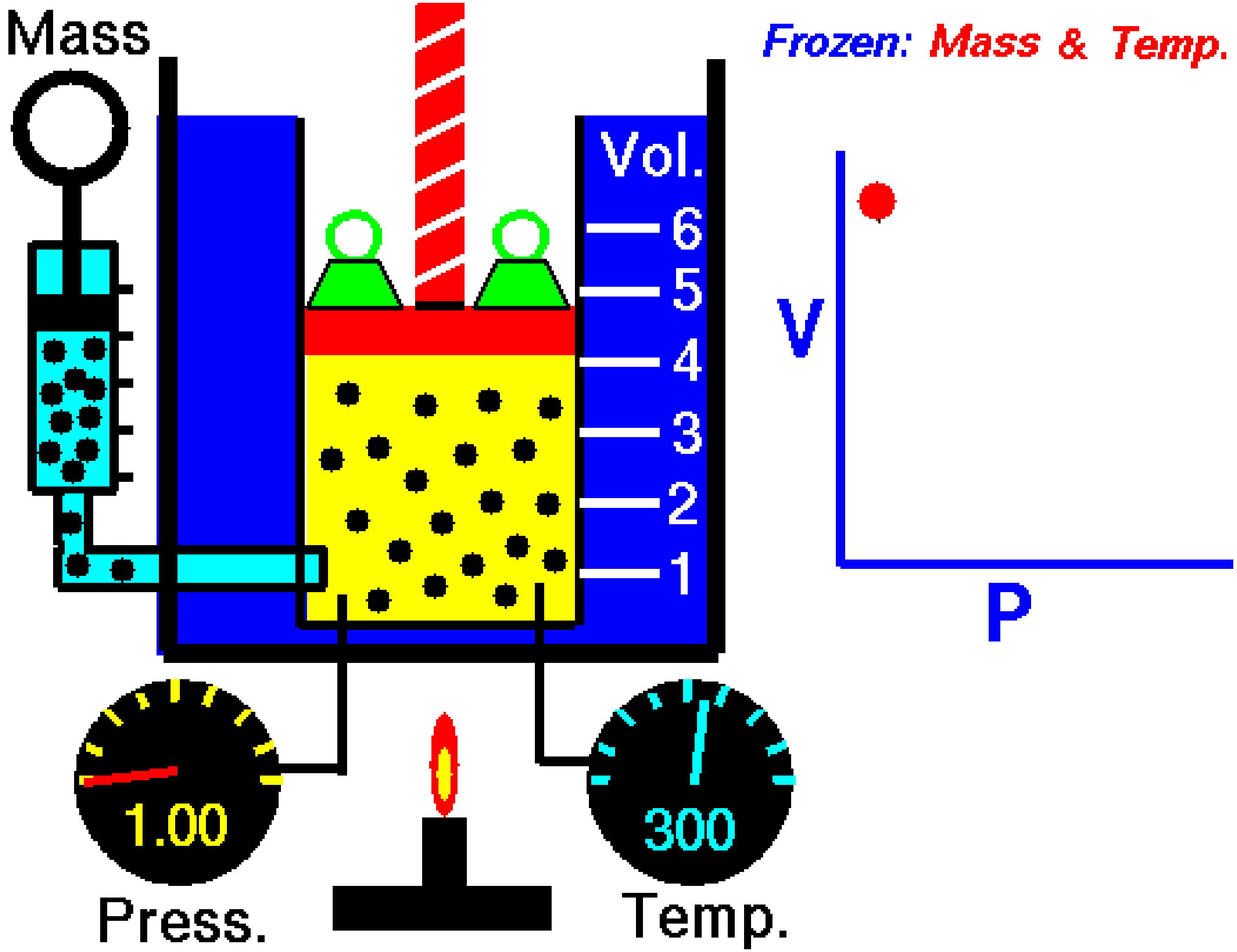
"a" is a constant that depends on the nature of gas

$VP = const$

$V_1P_1 = a = V_2P_2$

$$V_1P_1 = V_2P_2$$

1. Boyle’s law



2. Charles' law---it holds at constant pressure and mass

The volume of given gas is proportional to the temperature

$$V \alpha T$$

$$V = b * T$$

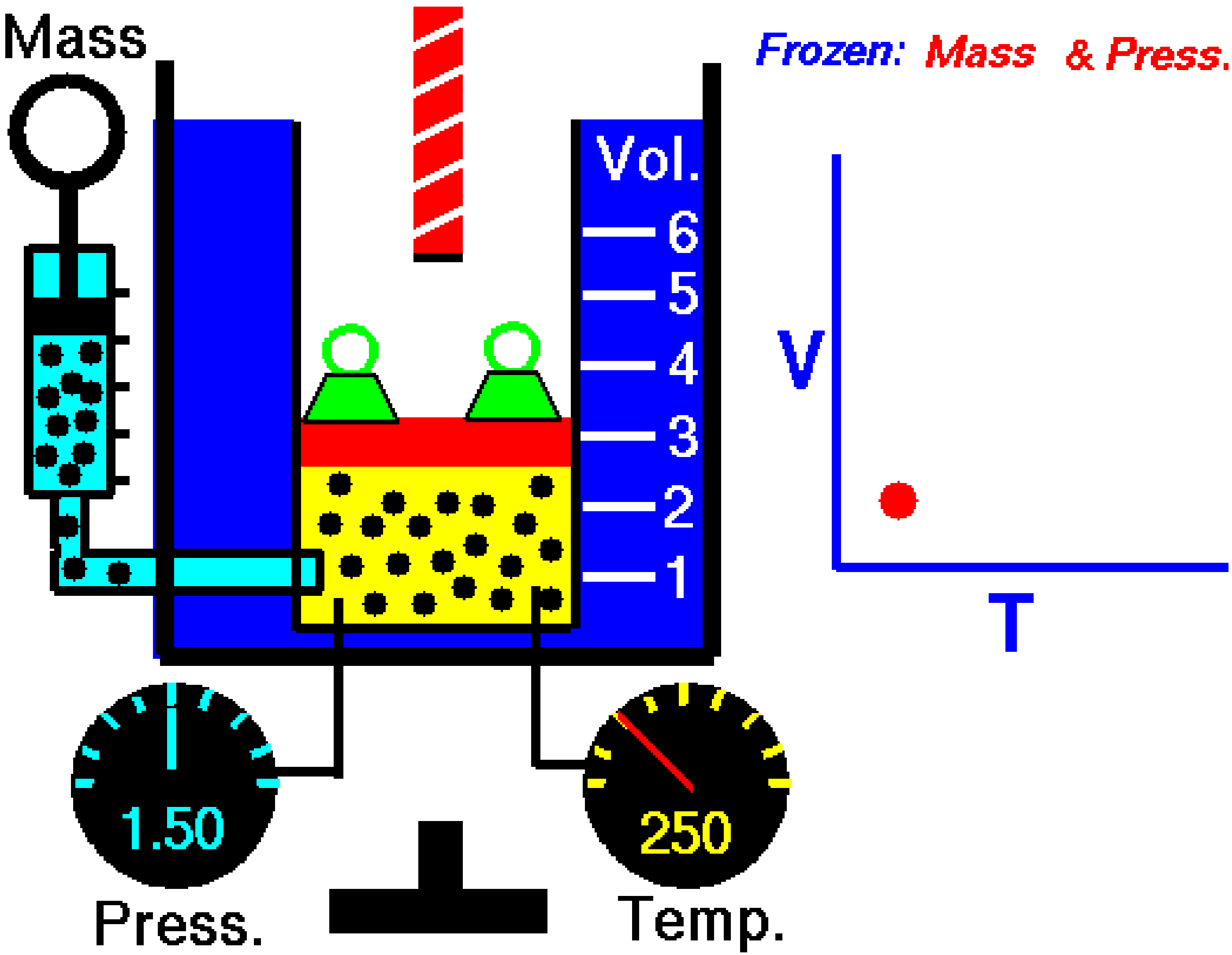
"b" is a constant that depends on the nature of gas

$$V/T = b$$

$$V_1/T_1 = b = V_2/T_2$$

$$V_1/T_1 = V_2/T_2$$

Charles' law



Avogadro's law

At constant Pressure and constant temperature (T), the Volume of given gas is proportional to the amount (moles) of that gas (n)

$$V \alpha n$$

$$V = g * n$$

where "g" is constant that depends on the gas present in the system

$$V/n = g$$

$$V_1/n_1 = g = V_2/n_2$$

$$V_1/n_1 = V_2/n_2$$

Consequence of Avogadro’s law is definition of so-called MOLAR VOLUME* Vm *:

At normal consgtant pressureP (P = 101 325 Pa) and constant Temperature T (T = 273 K), 1 mol (1 mol) of any gas has a volume of 22.4 dm^3 (22.4 L) – **this is called MOLAR VOLUME-Vm**

Definition of molar volume: Vm = V/n (Vm has unitsdm^3/mol)

Volume	22.4 L	22.4 L	22.4 L
Pressure	1 atm	1 atm	1 atm
Temperature	0° C	0° C	0° C
Mass of gas	39.95 g	28.01 g	2.02 g
Number of gas molecules	6.022 x 10^{23}	6.022 x 10^{23}	6.022 x 10^{23}

Law of ideal gasses

- $PV = nRT$

3. Закон за идеални гасови

-идеален гас е оној кај кого нема привлечни сили меѓу молекулите на тој гас

$$V \alpha (n * T)/P$$

$$V = R * (n * T)/P$$

where "R" = 8.314 J/(mol K) is universal gas constant

$$P * V = n * R * T$$

$$(P*V)/(n*T) = R$$

n is amount (mols) of given gas

T is thermodynamic temperature in Kelvin (K)

T(K) = 273,15 K + T(°C);

What can be used this equation for?

Density of gas (ρ) = m(gas)/V(gas)

$PV = nRT$

Каде $n = m/M$

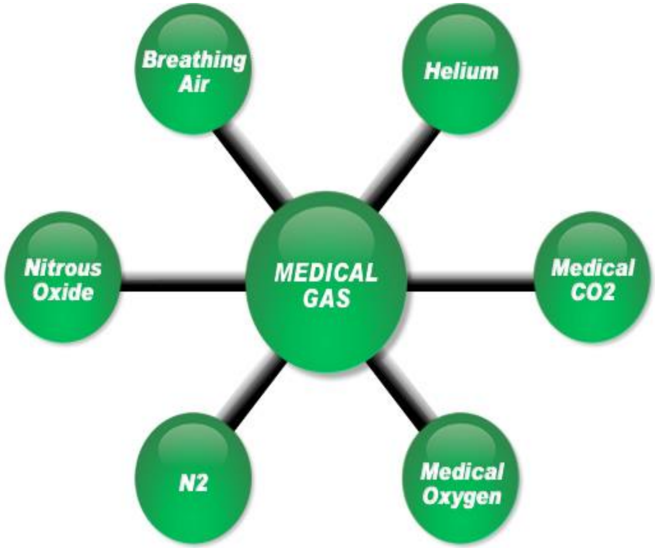
$PV = (m/M)*RT$

$M = (\rho*R*T)/(P*V)$

M-is molar mass of given gas and it can be used to identify some unknown gas present in container or in some room etc.

Medical gasses useful and toxic

- We breath earth's atmosphere composed of:
  - Nitrogen (78%) N_2
  - Oxygen (21%) O_2
  - Carbon Dioxide (0.03%) CO_2
  - Argon and trace gases (0.93%) Ar
    - Neon, Xenon, Krypton and Deon



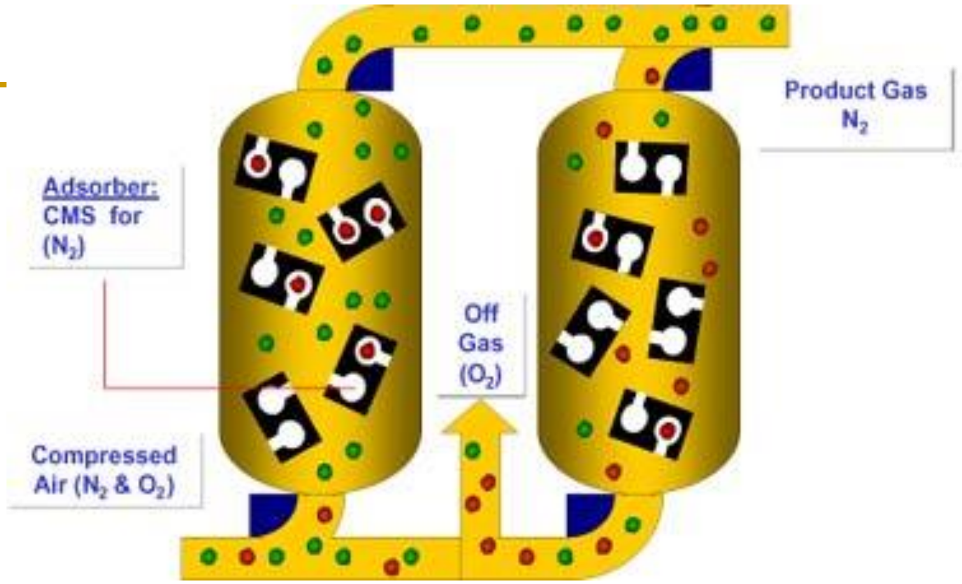
How Oxygen is produced

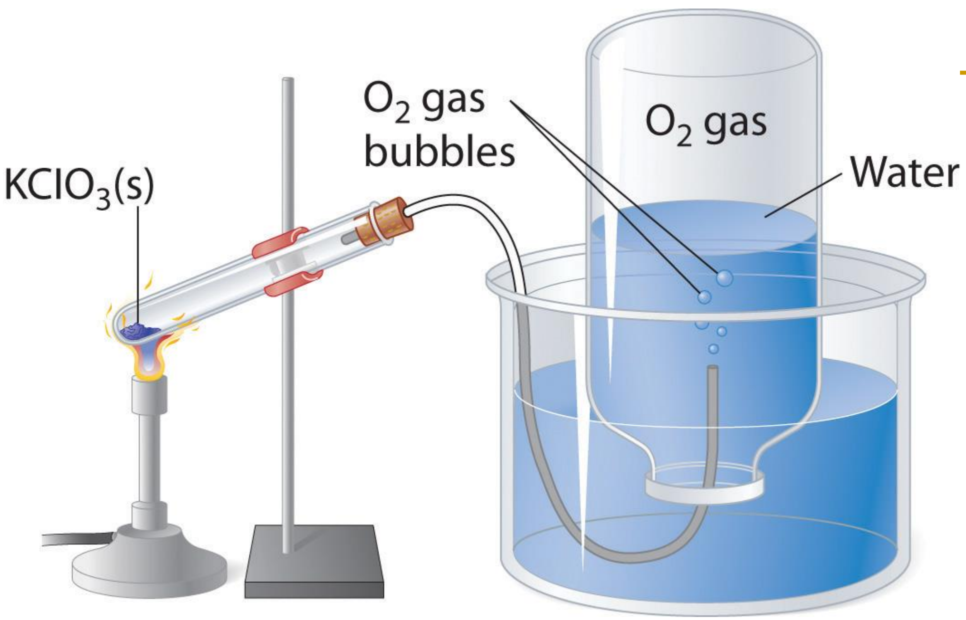
Fractional Distillation

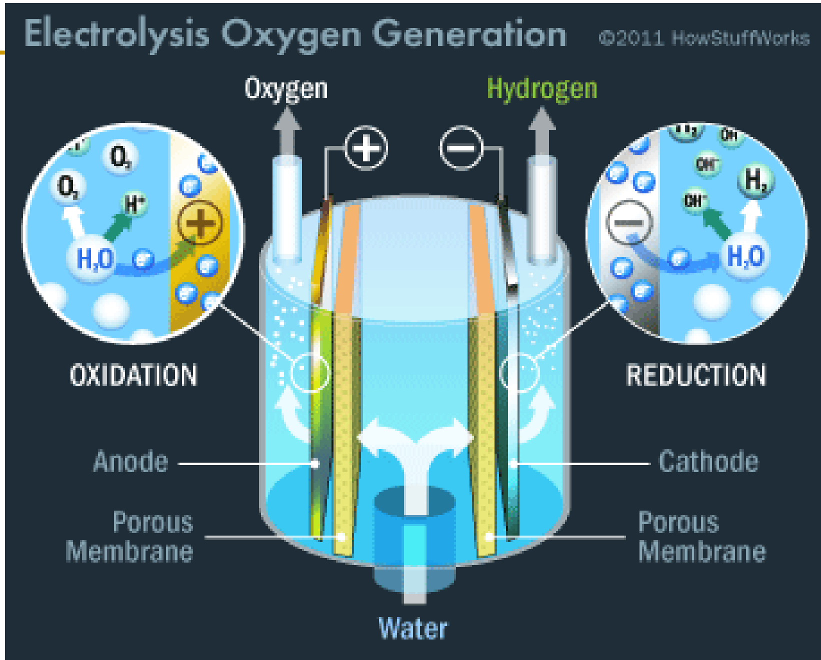
Physical Separation

-Nitrogen Molecular sieve

Semi-Permeable membrane





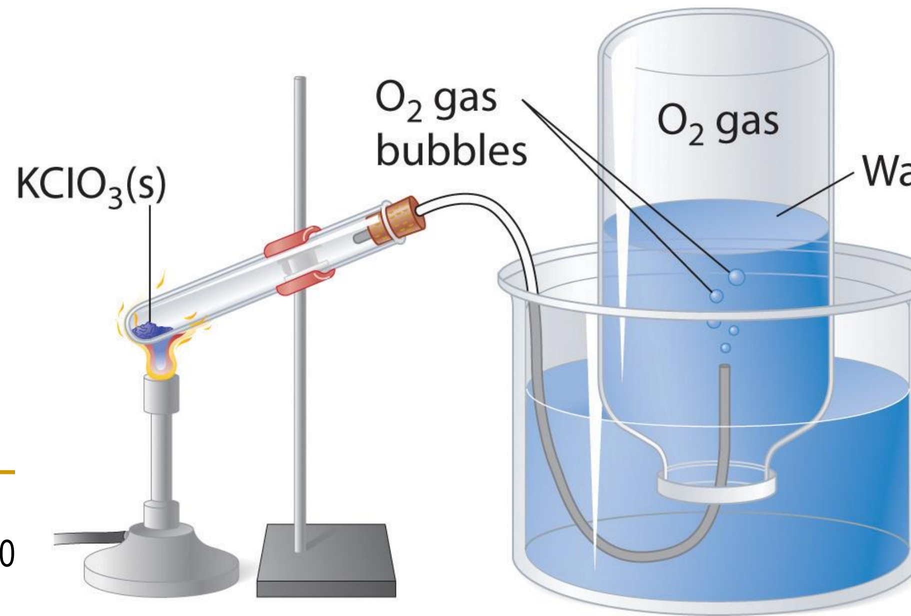


Oxygen

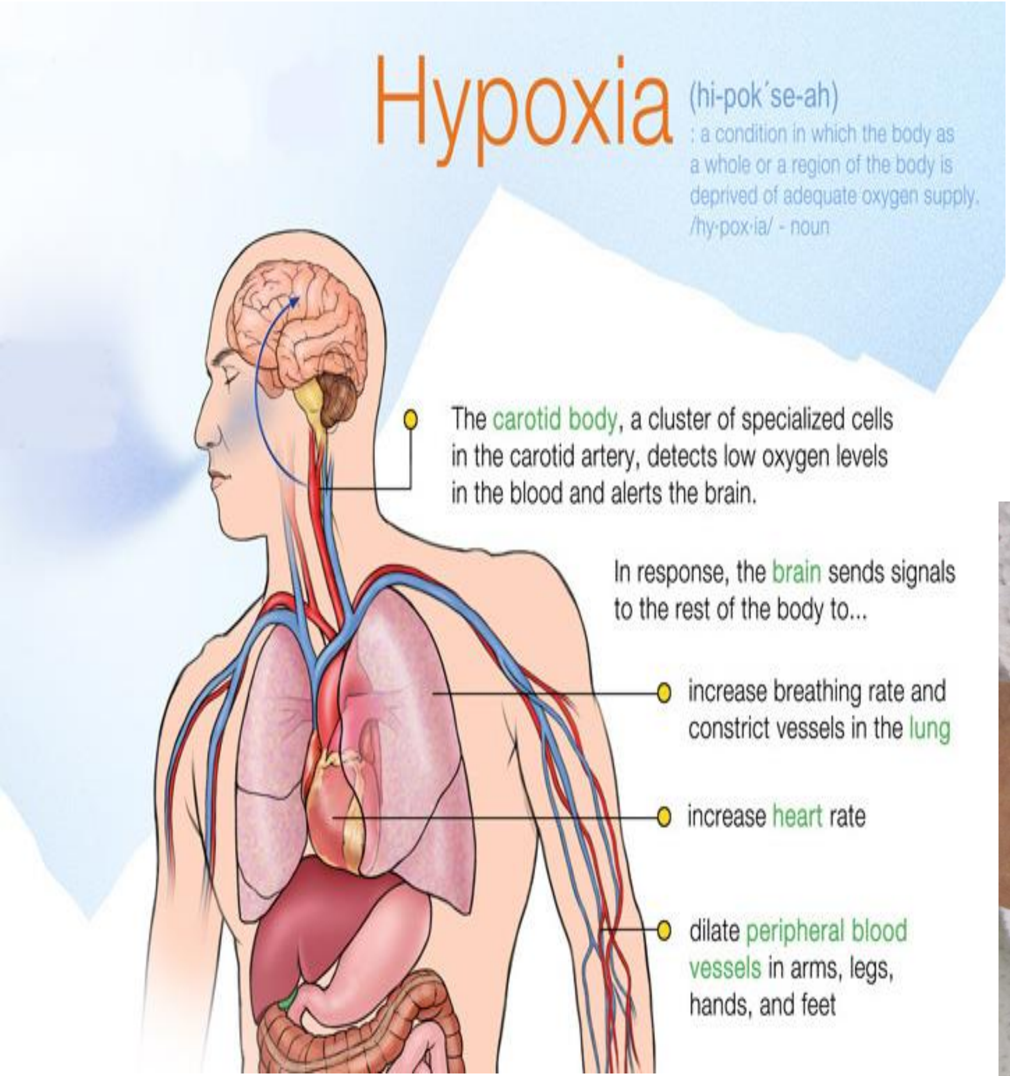
- O_2
- Molecular Weight 32
- Colorless, odorless, tasteless
- Slightly heavier than air
  - Density of 1.29 g/L
- Nonflammable

but supports

combustion

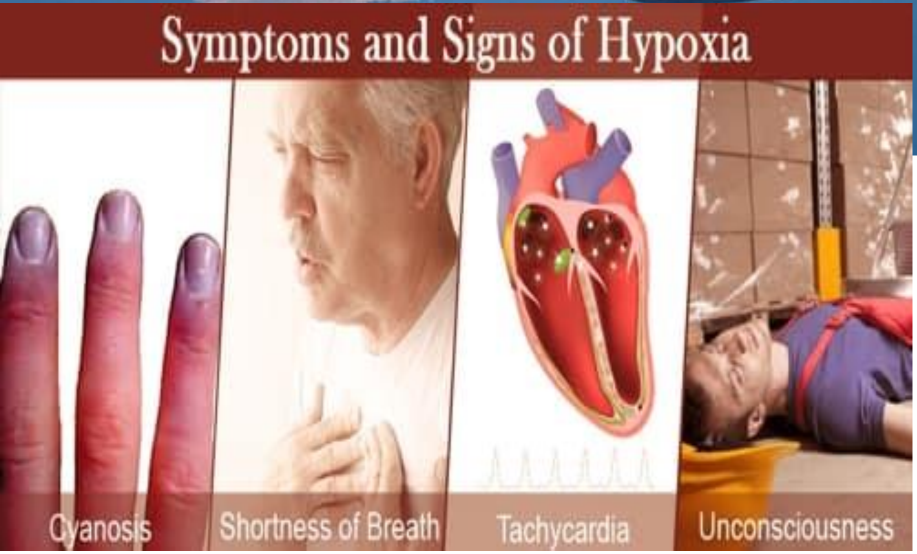


What happens if we have lack of Oxygen?

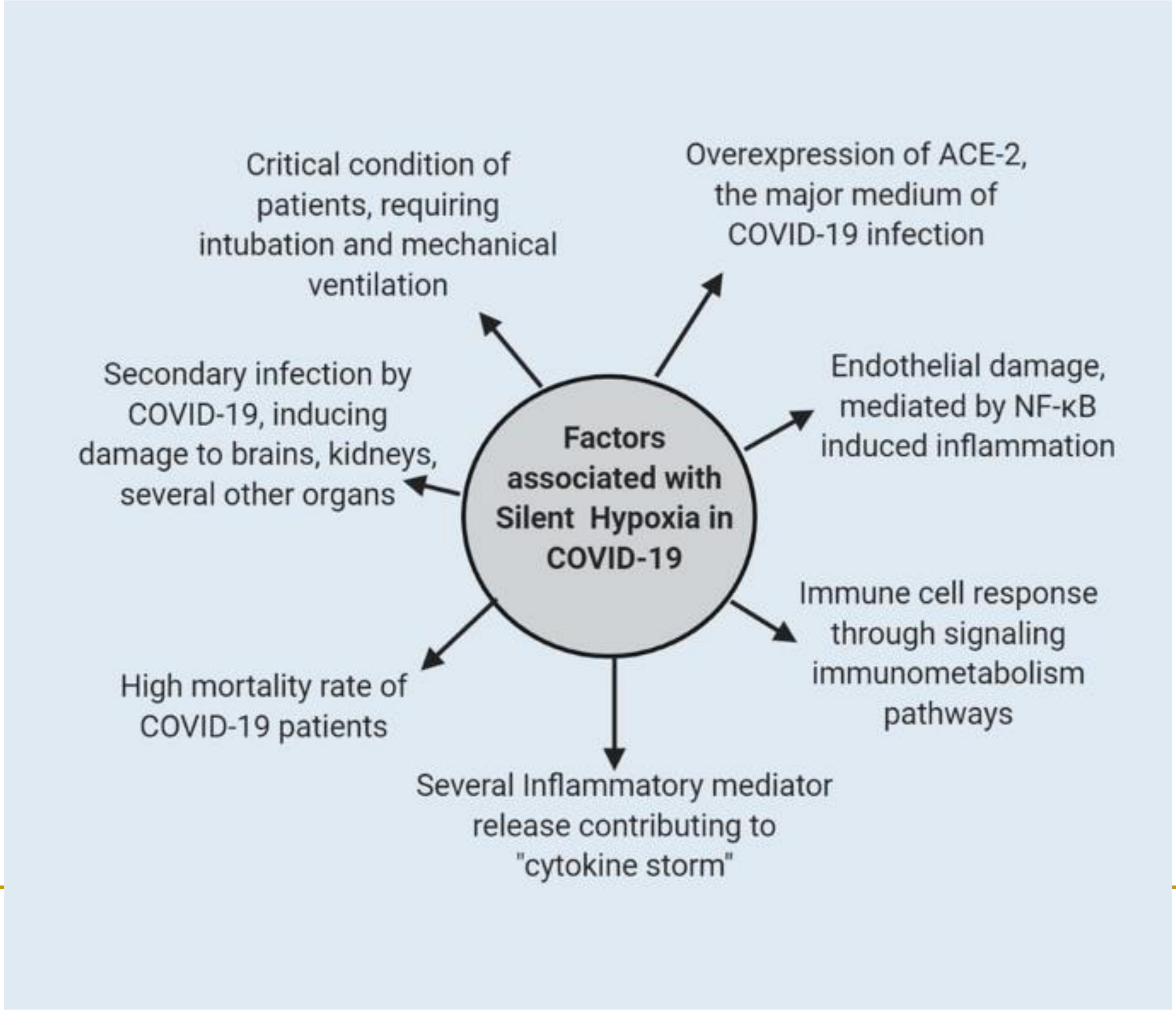


Loss of Pressure in Cockpit of Hellios Plane HYPOXIA

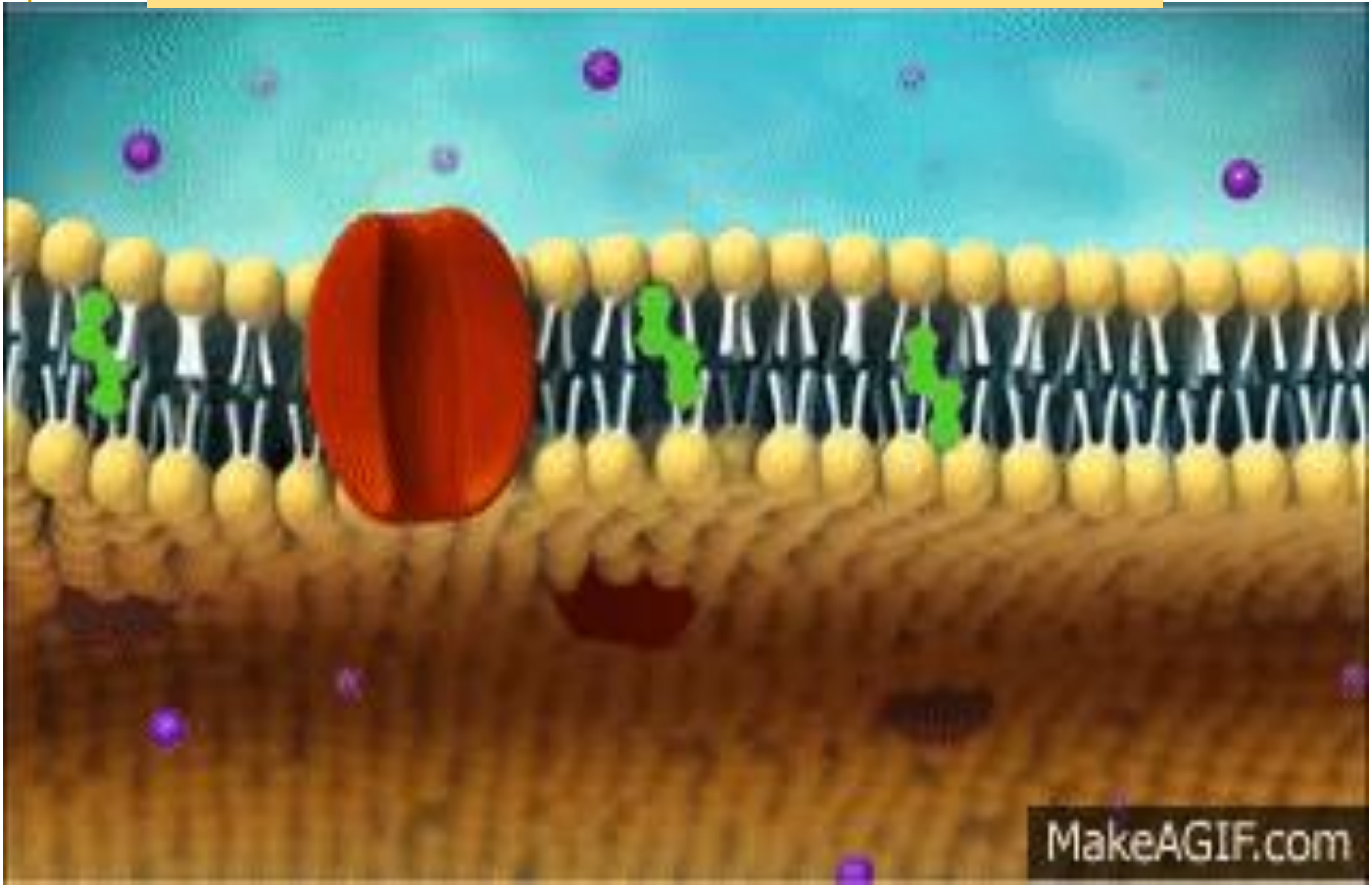
122 victims few years ago



Hypoxia-major cause for death of Covi-19 Patients



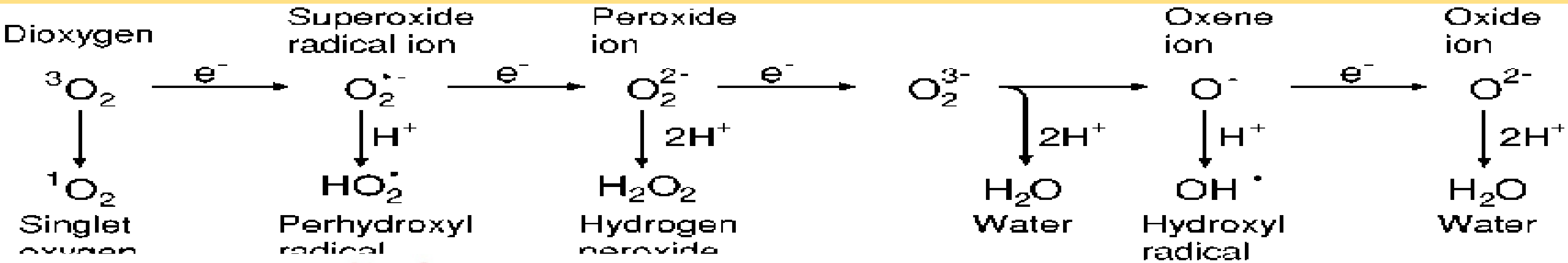
Scheme of phospholipid cell membrane

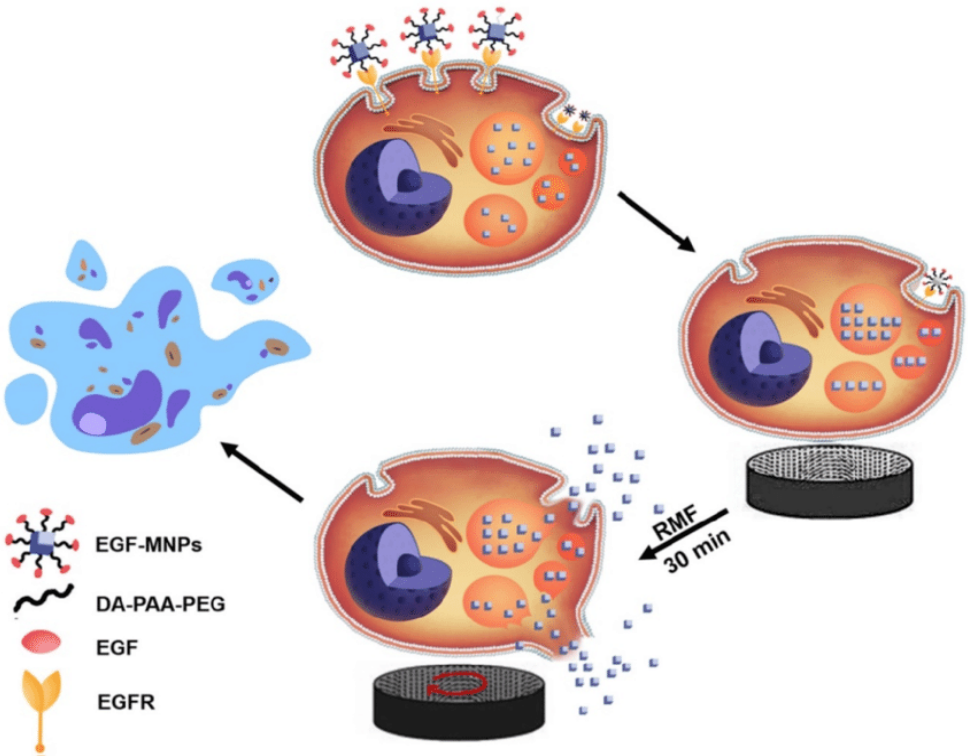


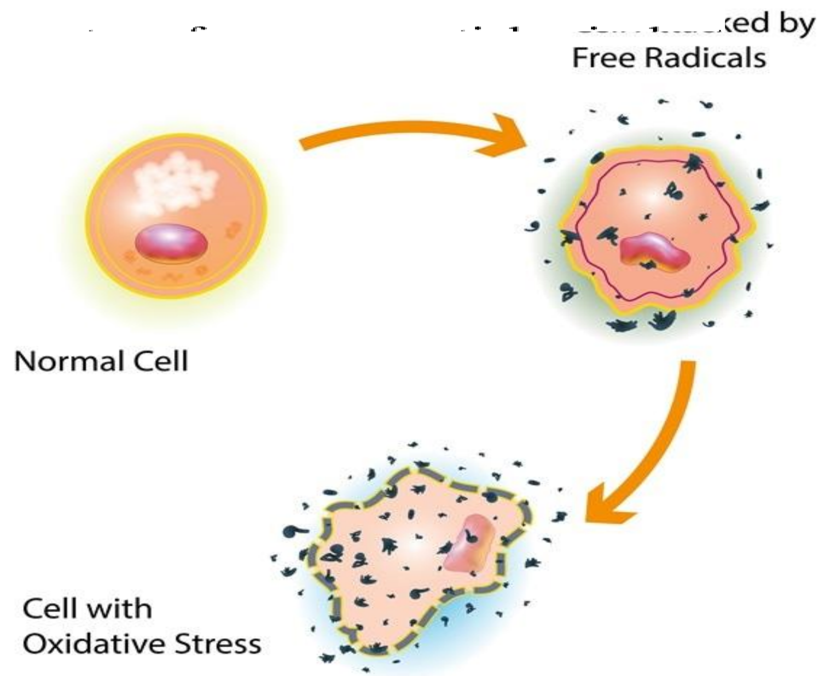
REMEMBER: EXCESS of OXYGEN in our body is ALSO HARMFULL!!!

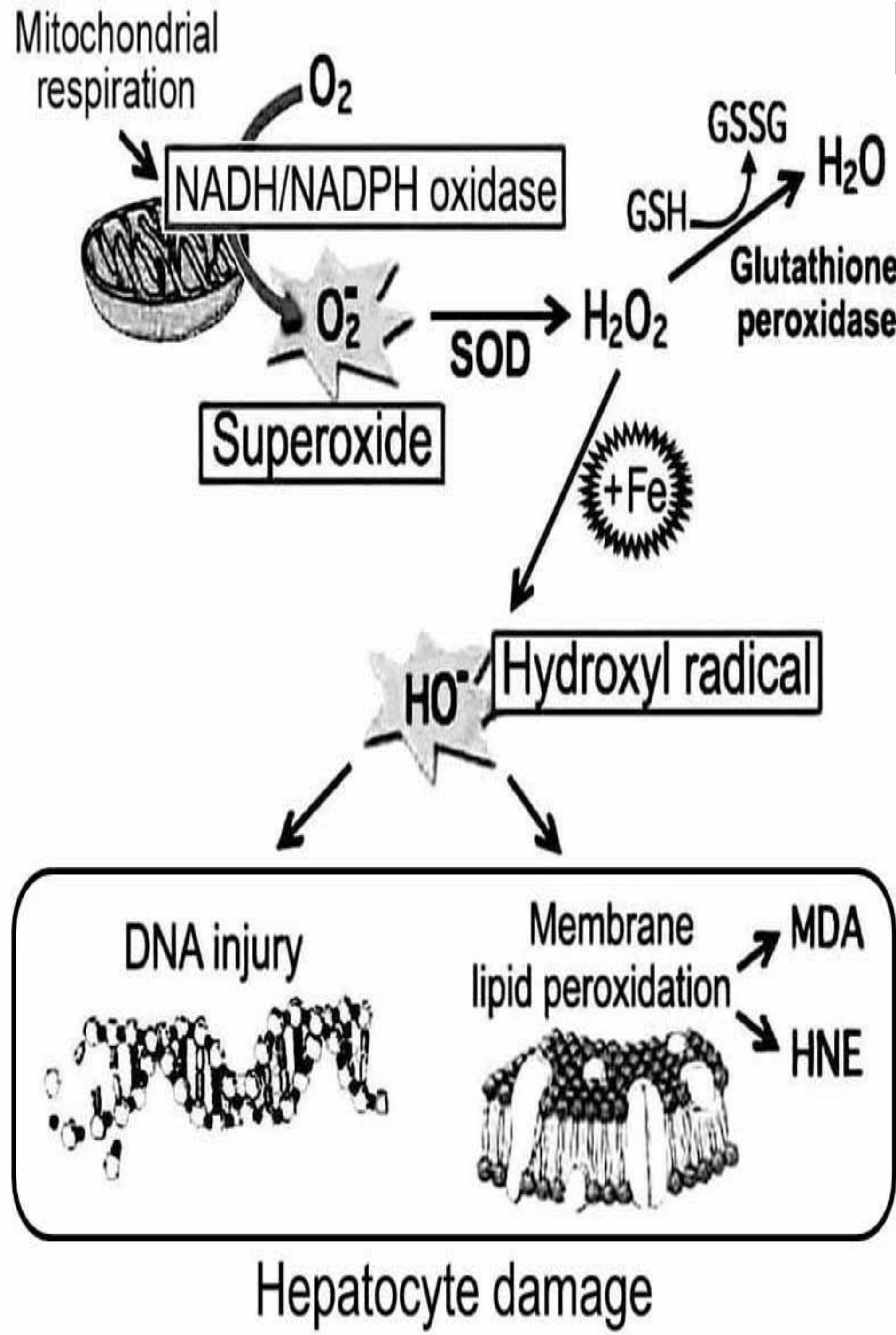
What happens if we supply Oxygen at large scales in our body?

...-Highly Aggressive so-called Reactive Oxygen Species are formed, like Superoxide radical, hydroxide radical, hydrogen peroxide…that mainly attack The MEMBRANE of THE CELLS, while damaging it and making it peremable

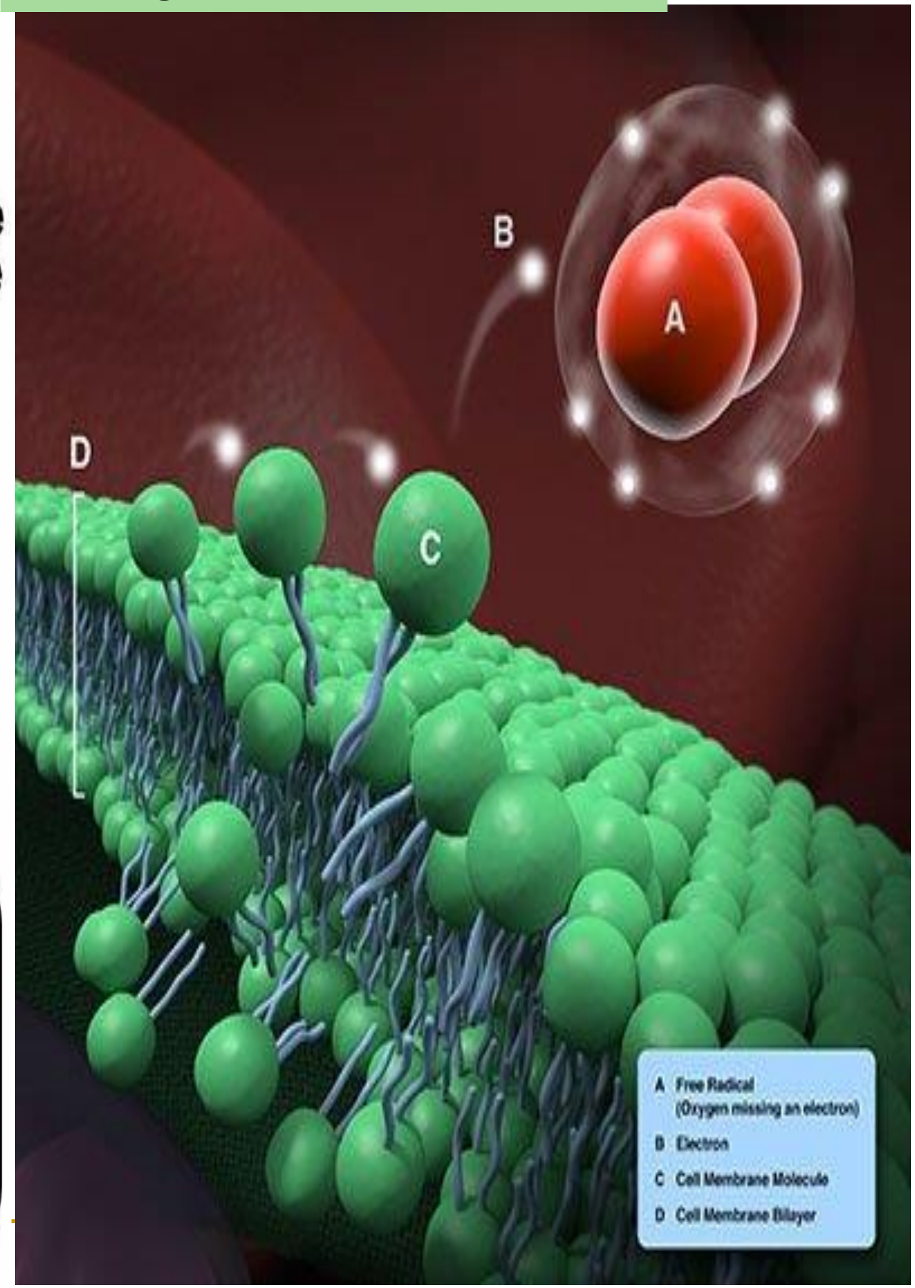






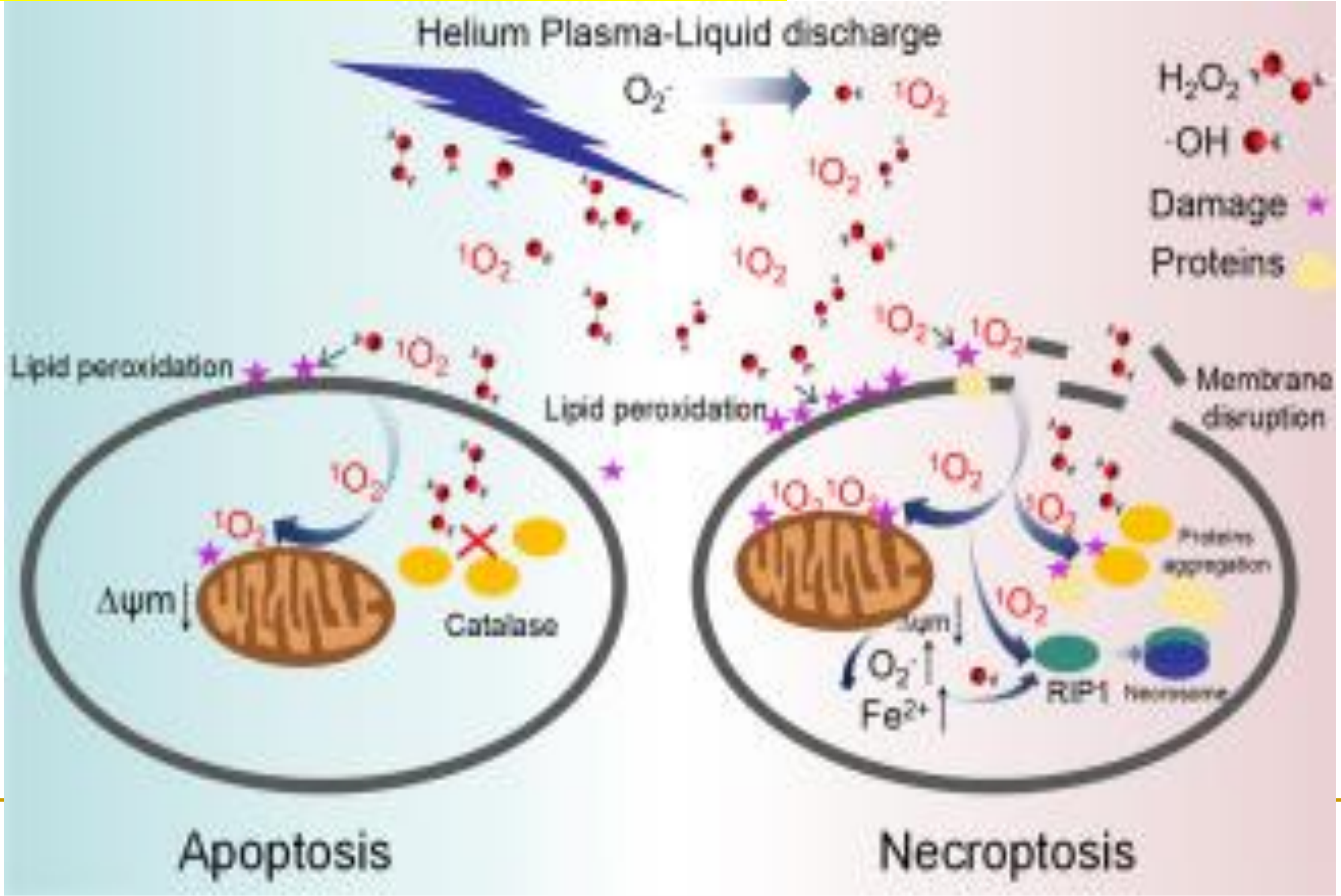


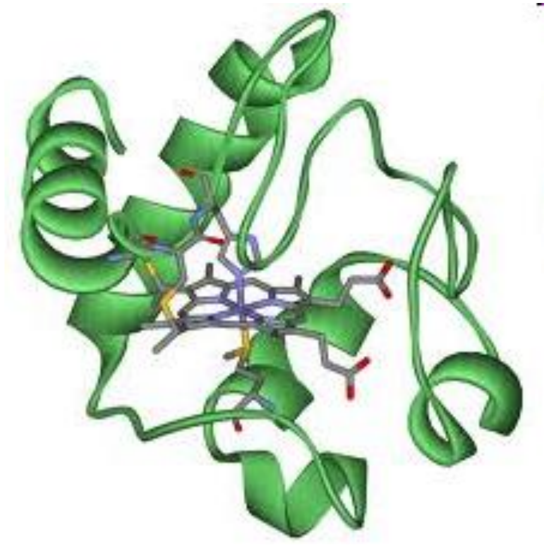
Damage of cell membranes

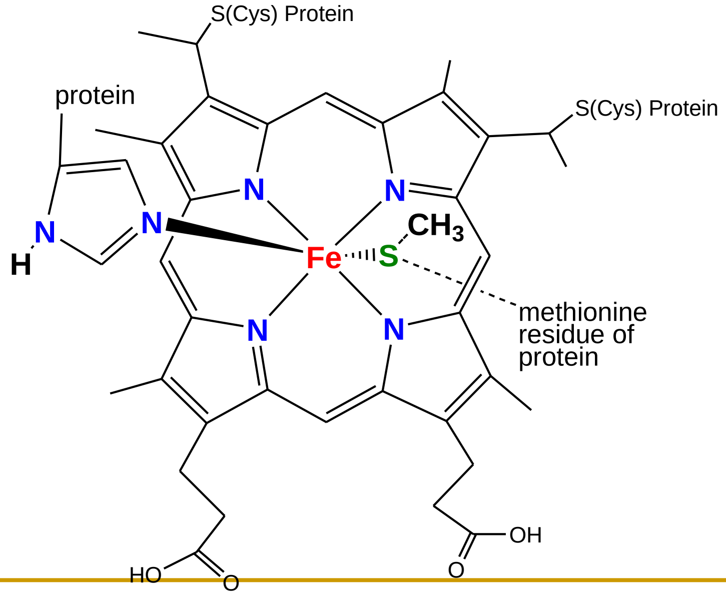


Apoptosis→ **A type of programmed cell death in which a series of molecular steps in a cell lead to its death**. This is one method the body uses to get rid of unneeded or abnormal cells.

Necroptosis is **an alternative mode of regulated cell death mimicking features of apoptosis and necrosis**







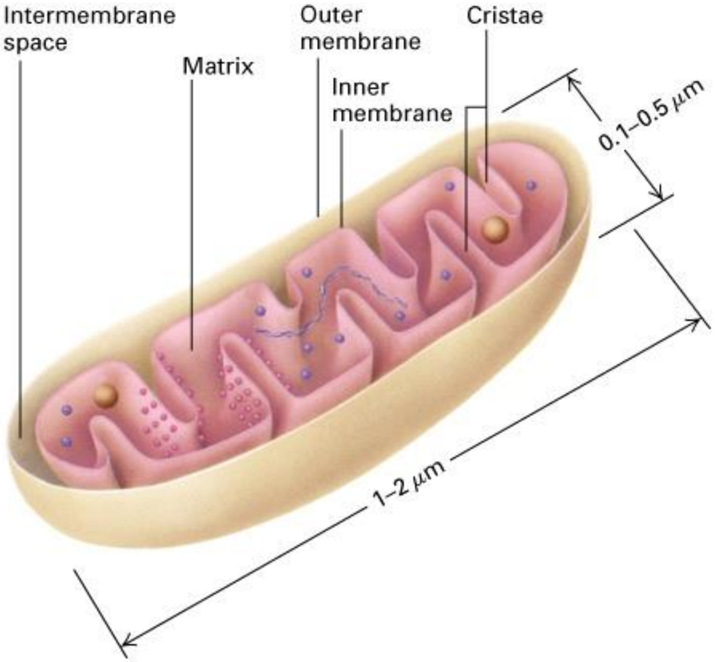
REMEMBER:

Oxygen is crucial element

To make conversion of the FOOD

to useful ENERGY in our body

Major energy production happens in MITOCHONDRIA



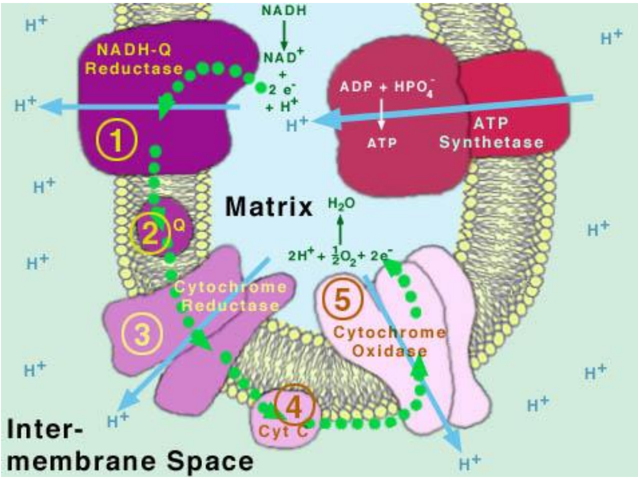
The energy is generated via creating molecules of ATP In a complex process in which oxygen plays a major role

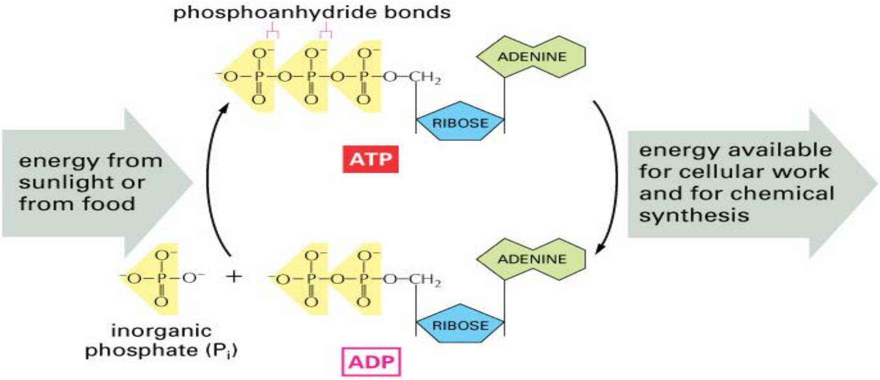
Glycolysis and Oxidative Phosphorylation are major Processes in which food turns to ATP

$$\text{Glucose} + 36\,ADP + 36\,Pi + 36\,H^+ + 6\,O_2 \longrightarrow 6\,CO_2 + 36\,ATP + 42\,H_2O$$

Glucose gives 18 times more energy when oxidized

$$ATP + H_2O \longrightarrow ADP + Pi + H^+ + \text{energy} \qquad \Delta G^0 = -7.3\ \text{kCal/mole}$$



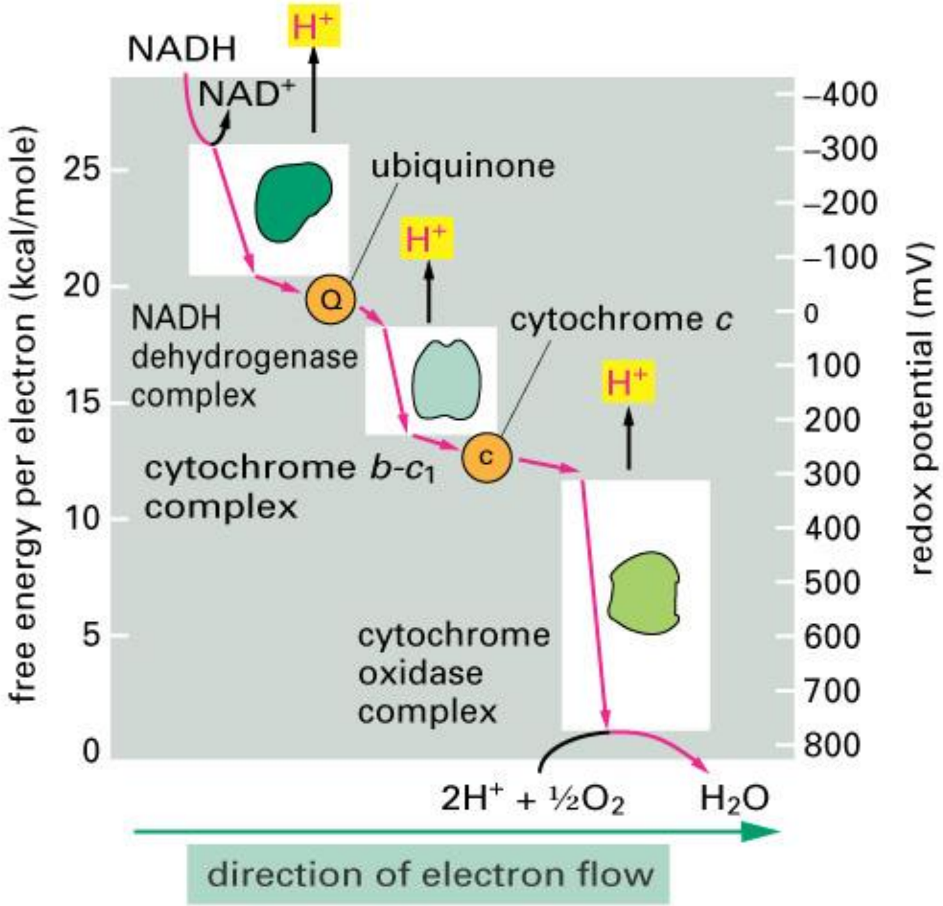


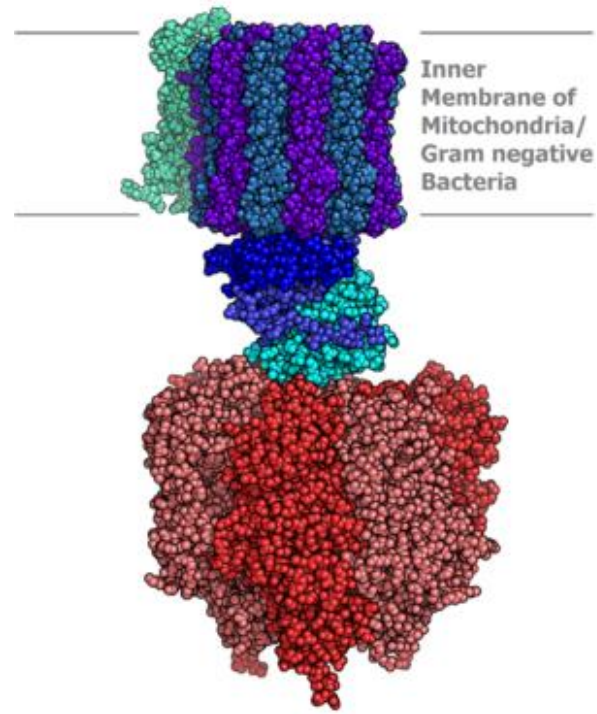
ATP : Universal currency for energy

in living systems

Different forms of Cytochromes (except Cytochrome P-450) are involved in the electron transfer process leading to ATP synthesis and conversion of O_2 to H_2O

See youtube video 'cellular respiration (electron transfer chain)'

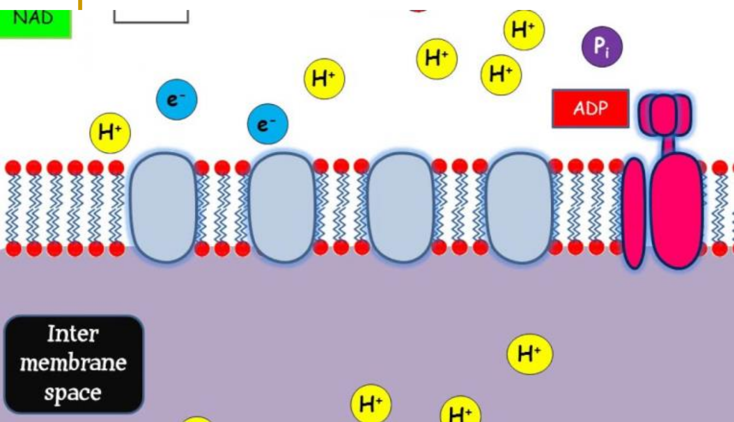


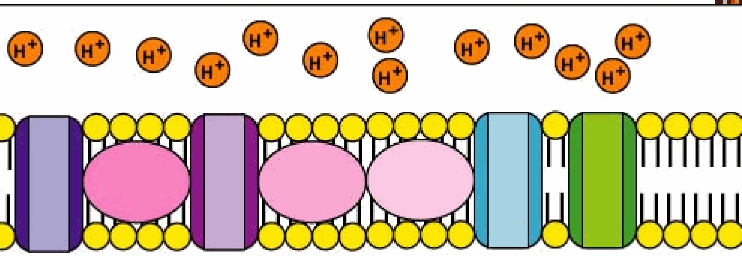


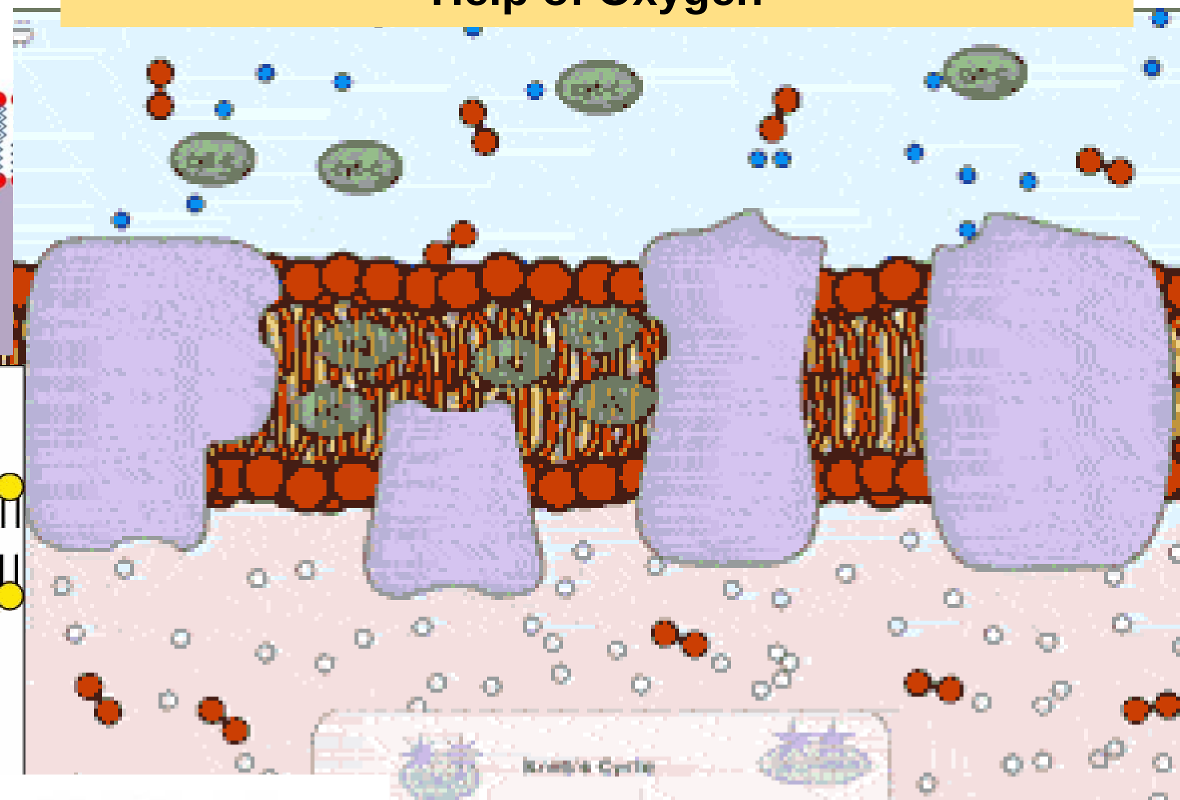
Actual structure of ATP synthase unit (a molecular machine!)

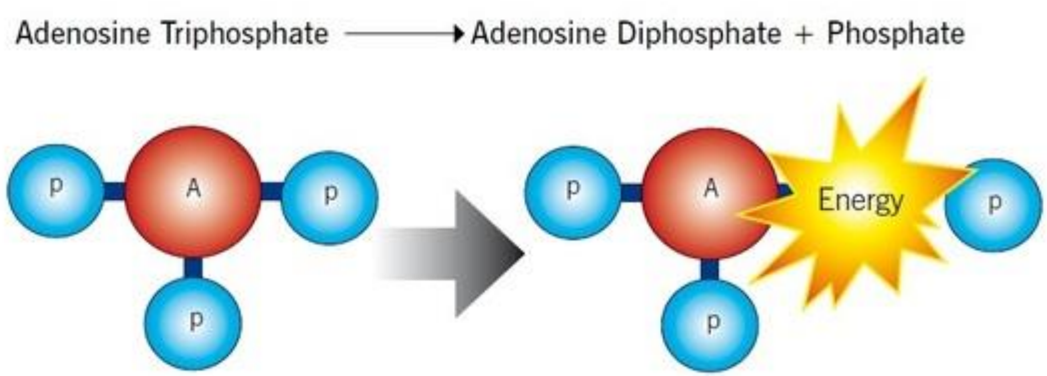
Cytochromes a and a_3	Cytochrome c oxidase with electrons delivered to complex by soluble cytochrome c (hence the name)
Cytochromes b and c_1	Cytochrome c reductase

Mitochondrial Electron transport Chain
Takes place in inner mitochondrial membranes, where food is converted to ATP with Help of Oxygen





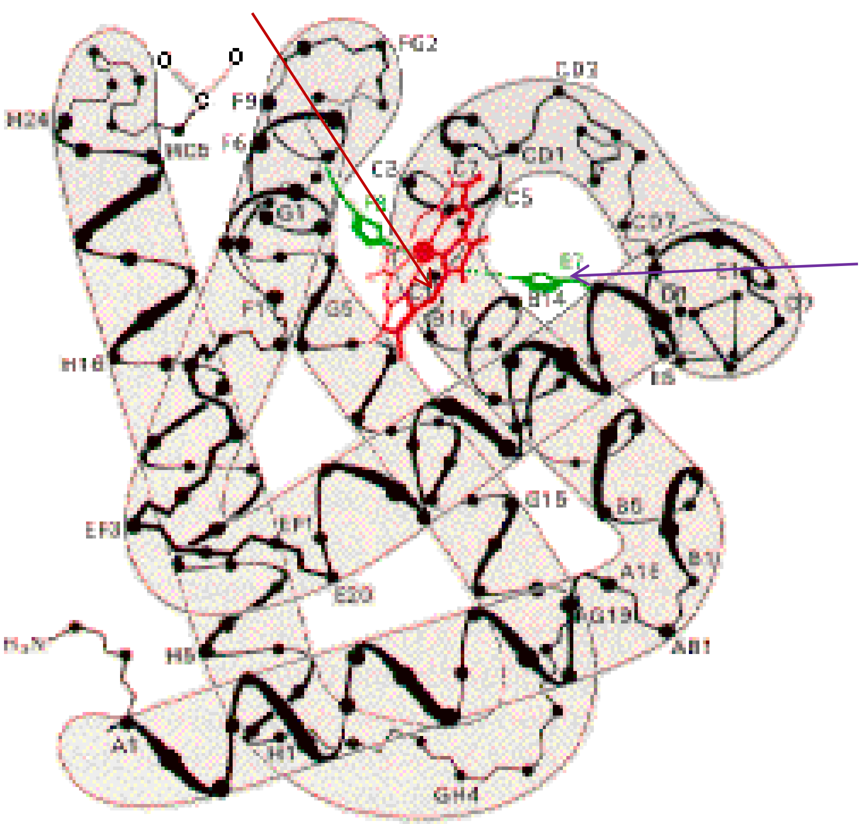


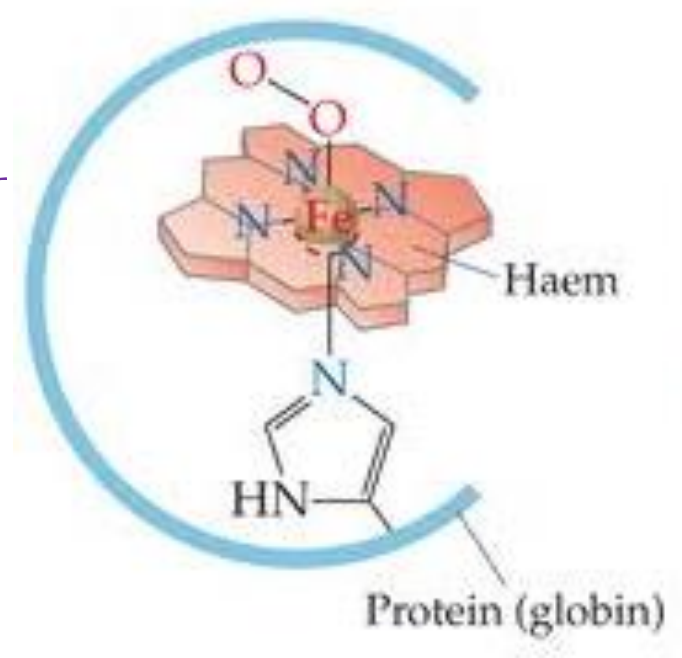


Remember: Energy we get from Conversion of food is in a form of HEAT!

O2 is stored in Myoglobin (Haem-like protein) in our body.

Do not forget: Iron of the Haem has ability to bind toxic gasses CO and HCN much much stronger than O2!!!





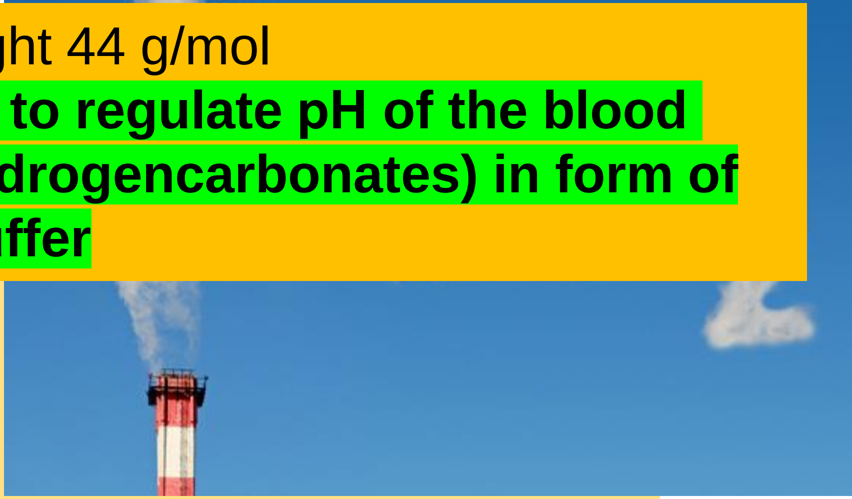
Other Medical gases (useful and harmful)

Oxygen, Carbon Dioxide, Helium, Nitrous Oxide, Nitric Oxide, Nitrogen, Carbon Monoxide

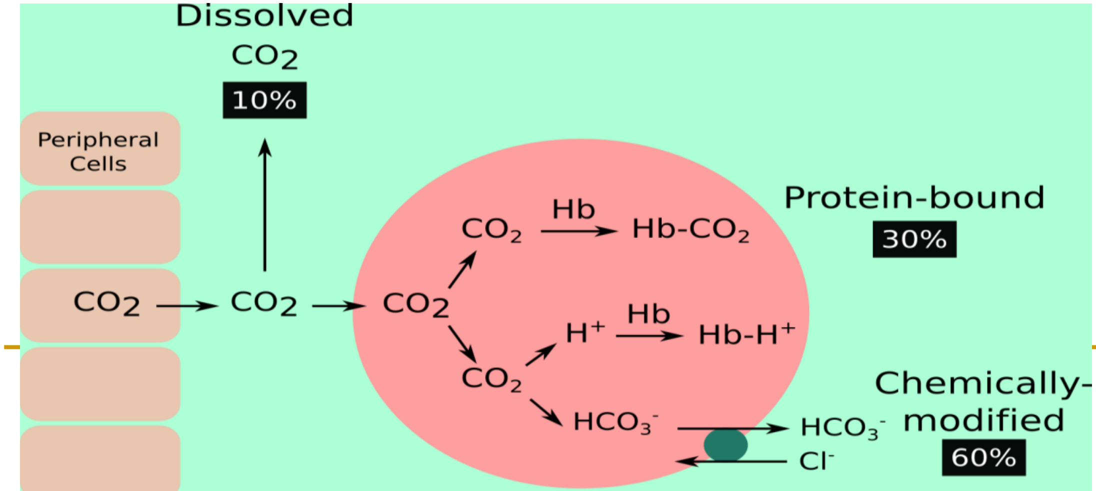
O_2; CO_2; He; NO; N_2O; N_2; CO

CO2

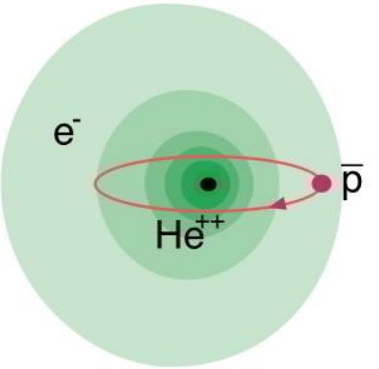
-----Molar weight 44 g/mol
-----**important to regulate pH of the blood (via HCO_3^- hydrogencarbonates) in form of Carbonate buffer**



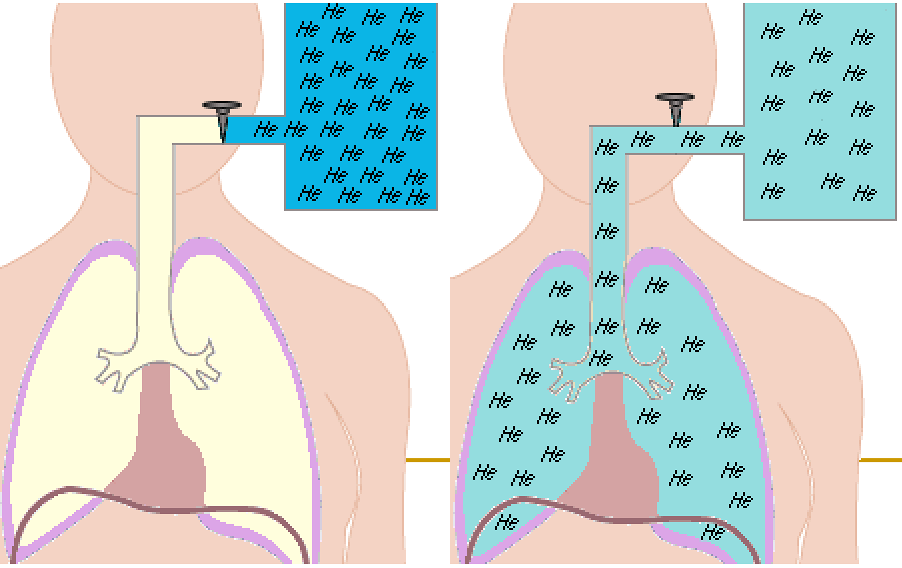
- CO_2
- Colorless and Odorless
- Does not support combustion
  - Used in fire extinguishers
- More soluble in liquids than oxygen
  - Easier transporting in blood then oxygen
- **Used to treat hiccups** (singulation)



Helium

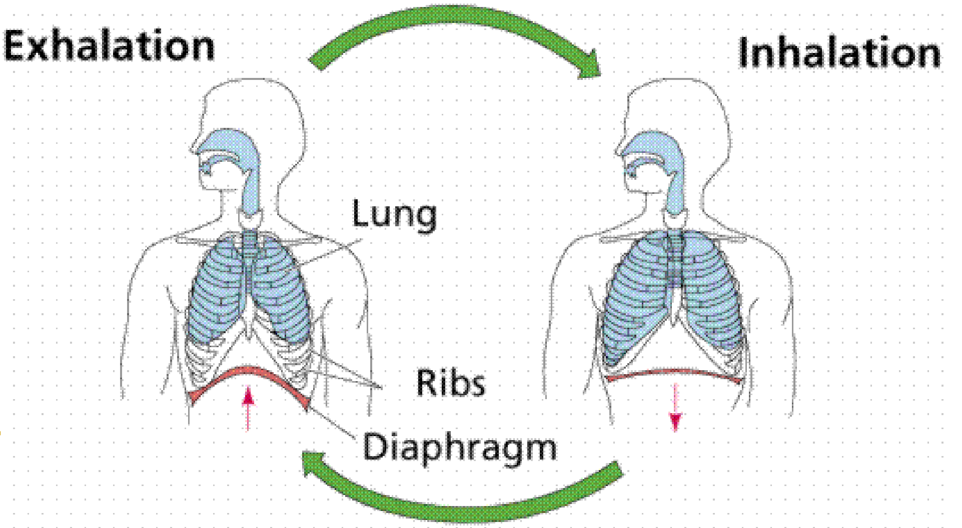


- He
- Odorless, tasteless, non-flammable
- Second lightest of gases
- Combined with oxygen (heliox) to reduce work of breathing with swollen upper airways



At beginning of gas dilution test

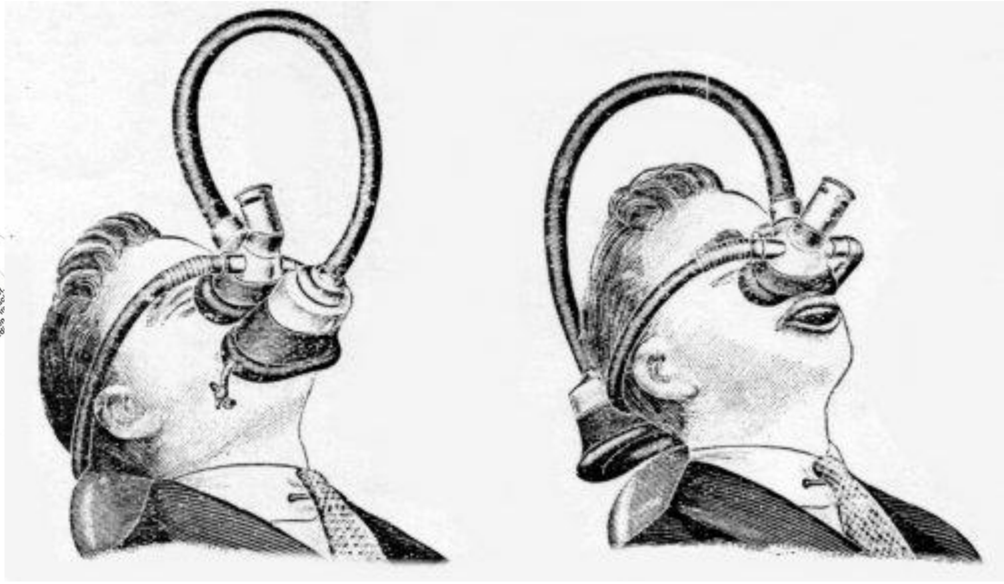
After several minutes



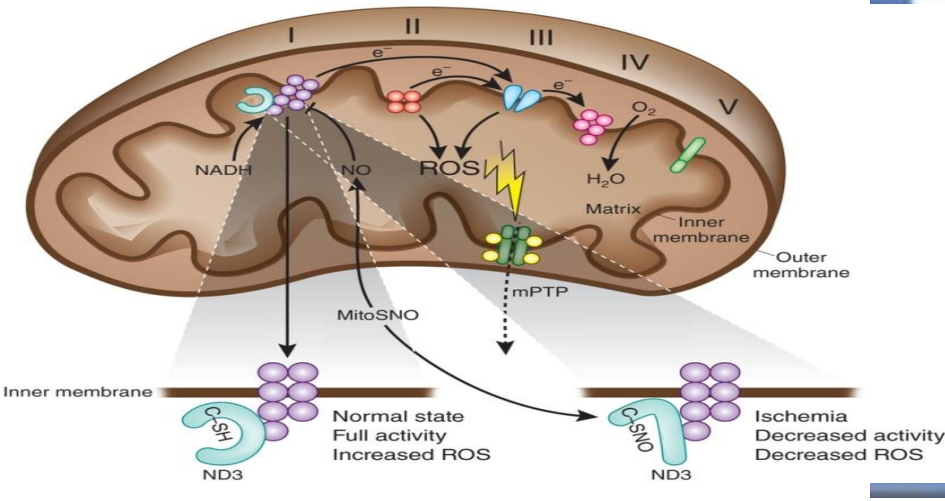
-----Molar Weight 44 g/mol

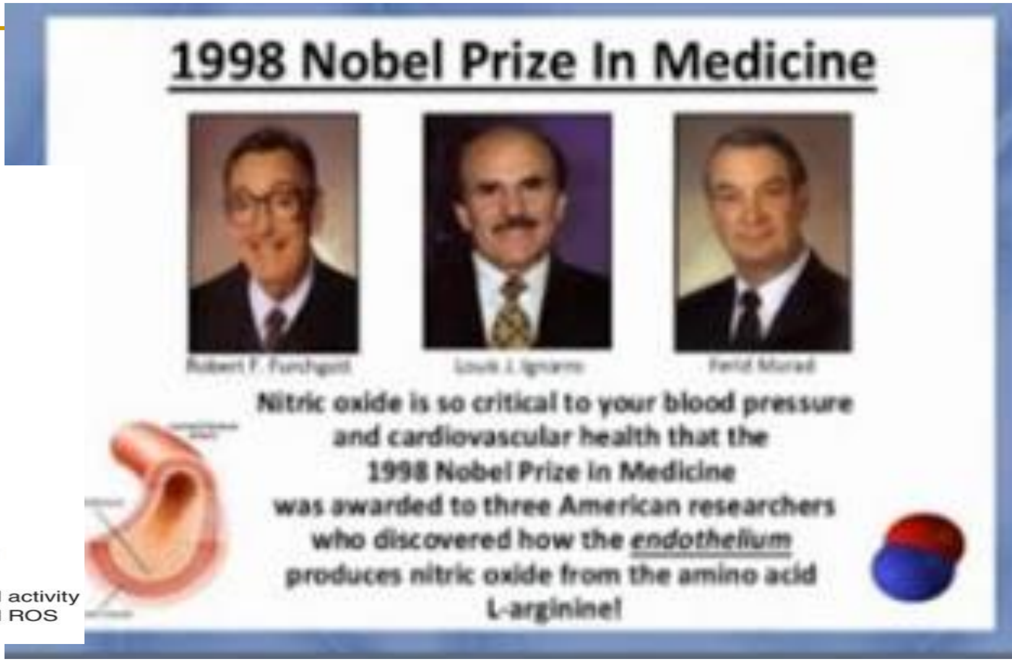
---------It is combined with O_2 in anesthetic processes

---”laughing gas„



Nitric Oxide



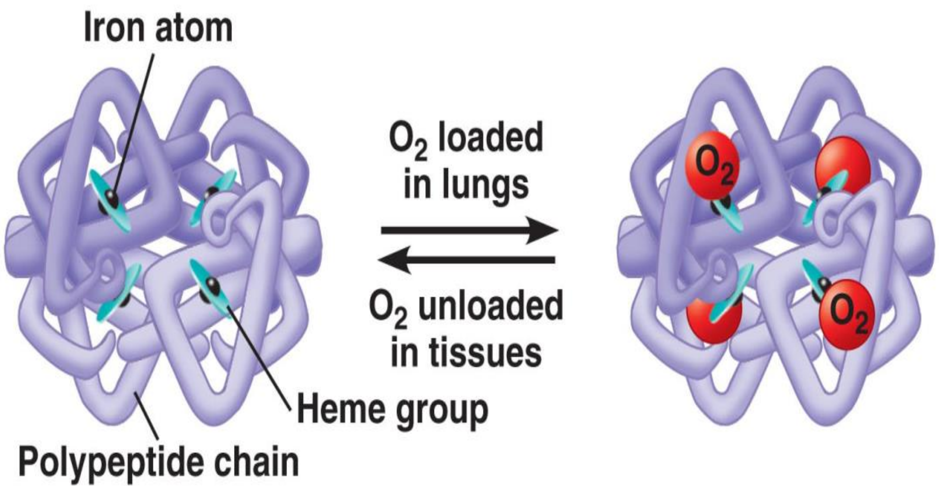


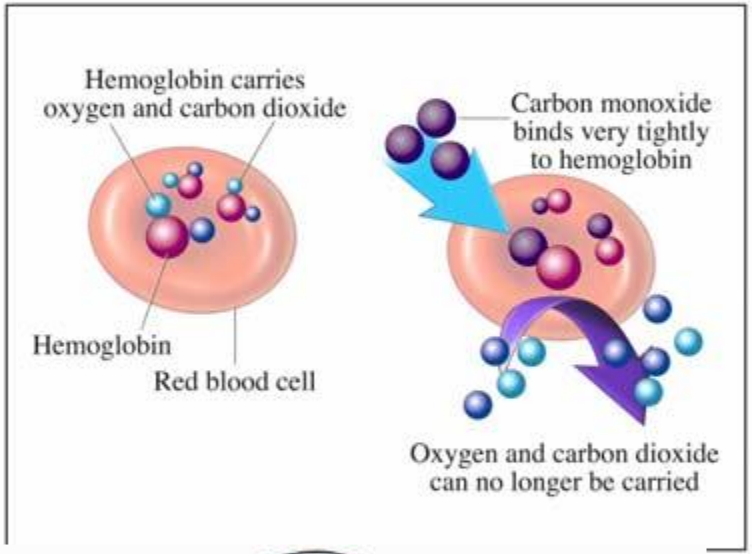
- NO
- Is nonflammable but supports combustion
- Used experimentally in low concentrations (ppm) for pulmonary vasodilation
- Recently has had excellent results with premature babies

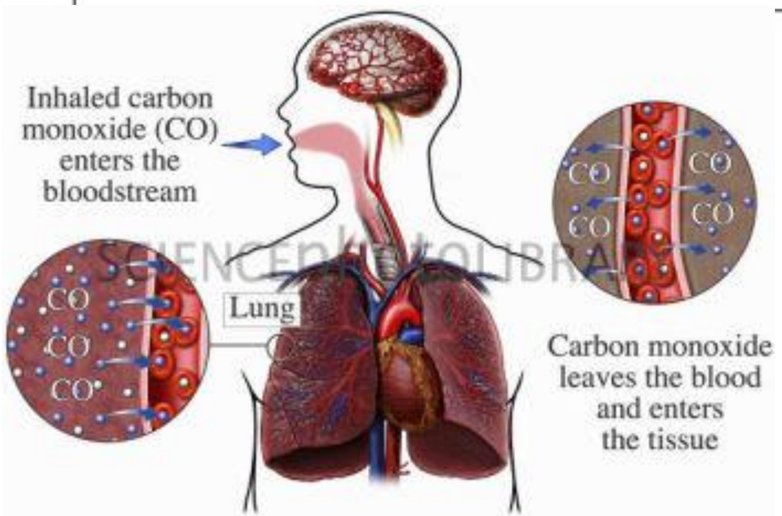
Nitrogen

- N_{2}- inert gas, most abandoned in the atmosphere
- Used as lab gas (liquid) for freezing tissue

Carbon Monoxide

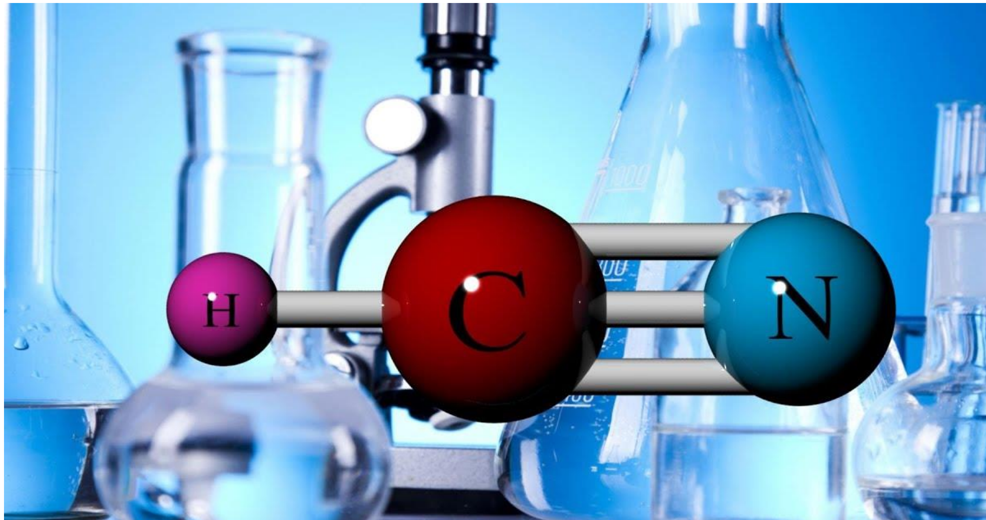


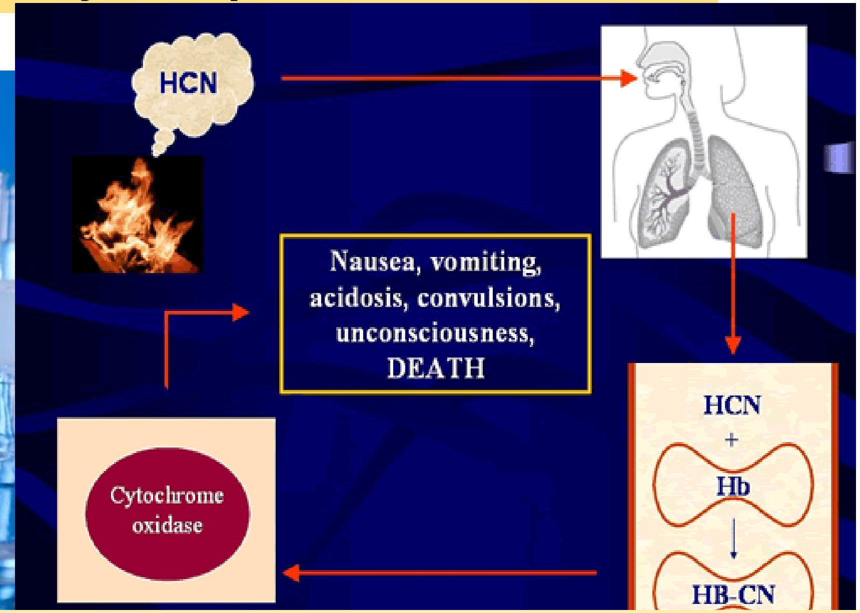




- CO
- Used in Pulmonary Function Lab
- Very diffusible – used to test how easily gas will pass through the lung membranes

TAKE CARE on “TWIN BROTHERS” i.e. EXTREMLY TOXIC GASSES CO (carbon monoxide0 and HCN (hydrocyanide)



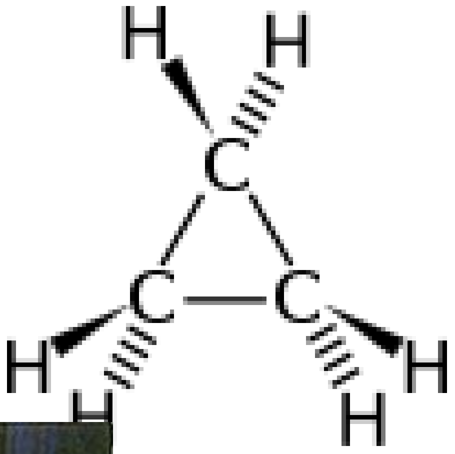


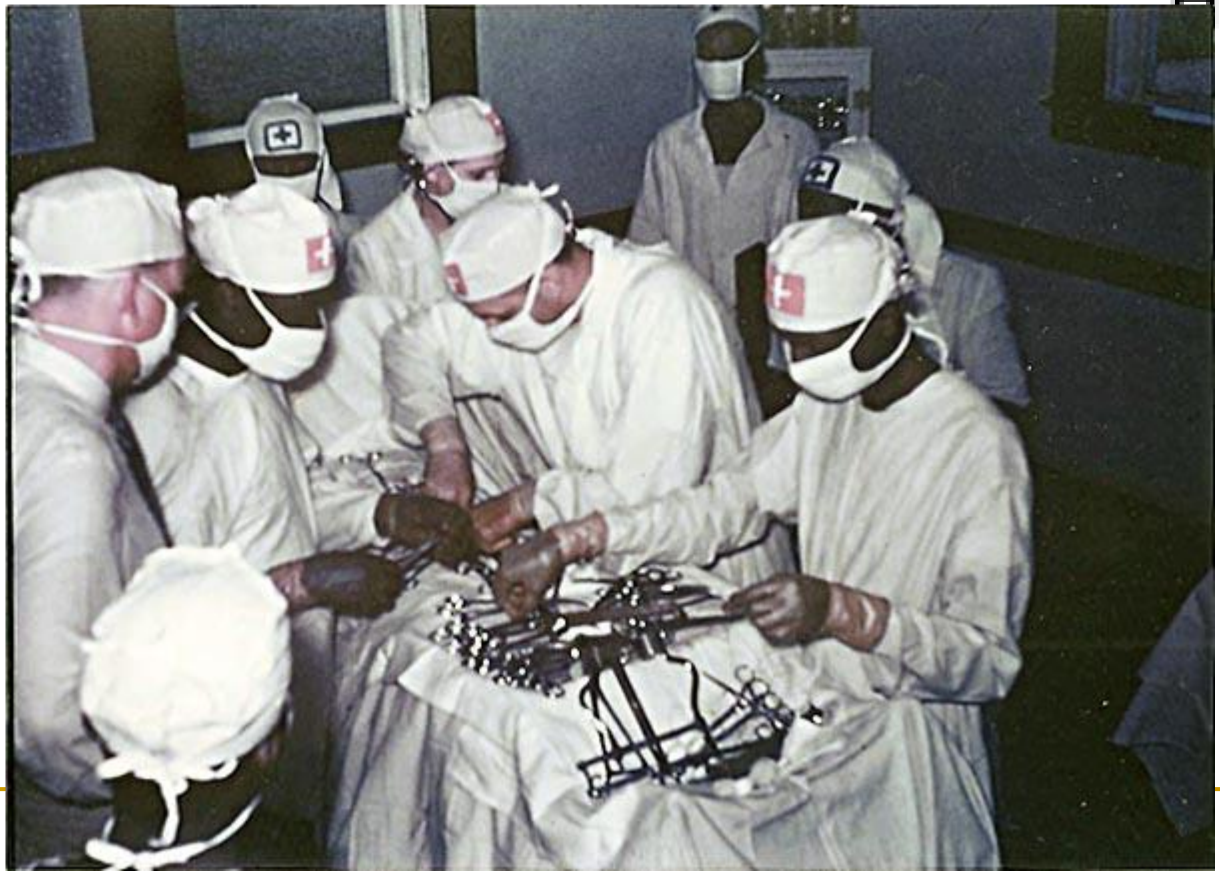
Slobodan Praljak-war criminal convicted in den Hague trial in 2017 drank KCN

Nazzi Marta Gebels had poisoned
Her 6 children in May 1945 in order not to
Fall in hands of Russian

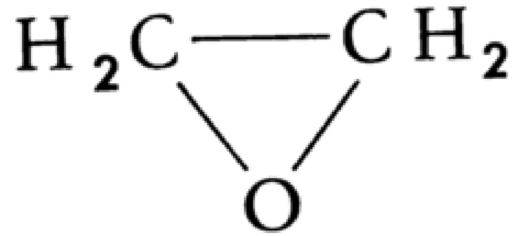
Cyclopropane

- Strictly an anesthesia gas





Ethylene Oxide



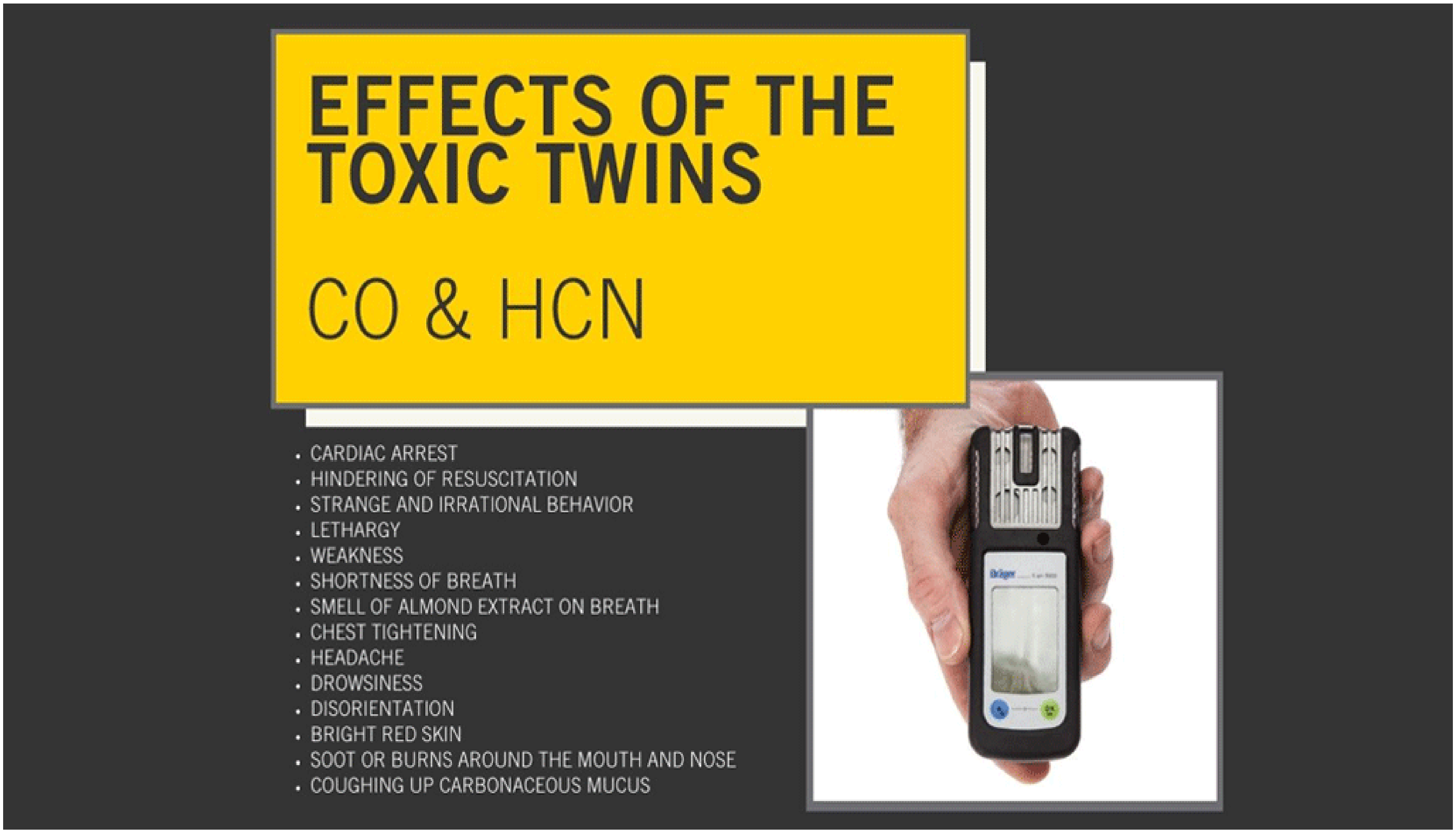
- Used to gas sterilize medical equipment
- Useful for equipment that can't handle high temperatures or immersion in water

Containers of O2 always green

Types of cylinders for holding gasses

	USA	ISO
Carbon Dioxide	Grey	Grey
$He\text{-}O_2$	Brown and Green	Brown and White
Medical Air	Yellow	Black and White
Nitrogen	Black	Black
Nitrous Oxide	Blue	Blue
$O_2\text{-}He$	Green and Brown	White and Brown
Oxygen	Green	White
Vacuum (Suction)	White	Yellow
WAGD (EVAC)	Purple	Purple

AGAIN---Be CAREFUL of twin-toxic brothers



https://www.bbc.com/news/world-europe-38821077

Germany Arnstein: Carbon monoxide killed six teens found in hut

1 February 2017

FOX6 MILWAUKEE LIVE News Weather Election WakeUp Real MKE Contests More

18-year-old, 16-year-old found dead in garage; police investigate possible CO poisoning

КАНАЛ 5 ТВ ВЕСТИ СПОРТ МАГАЗИН ПРОГРАМА ЕМИСИИ СЕРИИ ФИЛМОВИ ВЕБ ТВ

06:45 - ЗДРАВО МАКЕДОНИЈО (УТРИНСКА ПРОГРАМА) › 10:00 - МАКЕДОНСКИ ПРИКАЗНИ › 11:00 - ВЕСТИ › 11:10 - МЕТЕО › 12:0

МАКЕДОНИЈА

Девојка починала од труење со јаглероден моноксид - спиела во просторија која се затоплувала со печка на дрва (обновено)

Девојка на возраст од дваесет и една година починала од труење најверојатно со јаглерод моноксид а нејзината дваесет и двегодишна сестра се затрула од истата причина додека спиеле во помошна просторија од нивната семејна куќа што се затоплувала со печка на дрва. Трагедијата се случила вчера во долнореканското село Скудриње во периодот од полноќ до пладне.

Откриена причината за смртта на осумте млади за време на

8 Young Teens And been Poisoned by Silvester Night in Bosnia in 2020

Слободен печат

Пред 2 години

ŽANA PAVKOVIĆ
15. 9. 2001., Vrpolje, Posušje

IVAN MILIČEVIĆ
29. 8. 2001., Pokleċani, Posušje

MARIJA PAVKOVIĆ
16. 4. 2001., Vrpolje, Posušje

STIPE ROMIĆ
27. 9. 2001., Pokleċani, Posušje

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2. R Gulaboski, ES Ferreira, CM Pereira, MNDS Cordeiro, A Garau, Vito Lippolis, A Fernando Silva, ***J. Phys. Chem.*** C 112 (2008), 153-161

3. V. Mirceski, R. Gulaboski, *The Journal of Physical Chemistry B* 110 (2006), 2812-2820

4. M Janeva, P. Kokoskarova, V. Maksimova, R. Gulaboski, ***Electroanalysis*** 31 (2019), 2488-2506

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6. P. Kokoskarova, R. Gulaboski, ***Electroanalysis*** 32 (2020), 333-344