What life is

General context

What is Life?

No one truly knows what life is.

We only know its manifestations:

movement, respiration, digestion, physiology even though we experience these normal manifestations most often without realizing it, as pathology, without being aware of **the Wonder that is life**, at each of its levels, at each of its stages.

What is Life?

Life is being alive.

It is a form of "animation."

The meaning of life

To be, not to have.

To be, in order to become. This presupposes **intention.**

To live in order to exist, and to exist in order to act.

This implies introducing the concept of energy into the understanding of Life.

The concept of energy and the mechanisms of Life : introduction

First, it's important to understand that the universe, which was of course the origin of everything we know, is made of matter and energy.

This relationship, long misunderstood, was finally expressed mathematically by the genius of the last century, Albert Einstein, who established the connection between energy and matter with the famous formula $E = mc^2$, where µ is energy, m is mass, and c is the speed of light squared.

The matter is made of atoms.

An atom is the smallest part of an element, containing all the components of that element, and it was Mendeleev who actually established the classification of the different atoms that make up the matter of the universe.

PERIODIC TABLE OF ELEMENTS

Atomic Mass

Atomic Number: 17 — Symbol: **Cl** — Name: Chlorine — Atomic Mass, u: 35.45

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 **H** Hydrogen 1.0080																	2 **He** Helium 4.00260
2	3 **Li** Lithium 7.0	4 **Be** Beryllium 9.012183											5 **B** Boron 10.81	6 **C** Carbon 12.011	7 **N** Nitrogen 14.007	8 **O** Oxygen 15.999	9 **F** Fluorine 18.99840316	10 **Ne** Neon 20.180
3	11 **Na** Sodium 22.9897693	12 **Mg** Magnesium 24.305											13 **Al** Aluminum 26.981538	14 **Si** Silicon 28.085	15 **P** Phosphorus 30.97376200	16 **S** Sulfur 32.07	17 **Cl** Chlorine 35.45	18 **Ar** Argon 39.9
4	19 **K** Potassium 39.0983	20 **Ca** Calcium 40.08	21 **Sc** Scandium 44.95591	22 **Ti** Titanium 47.867	23 **V** Vanadium 50.9415	24 **Cr** Chromium 51.996	25 **Mn** Manganese 54.93804	26 **Fe** Iron 55.84	27 **Co** Cobalt 58.93319	28 **Ni** Nickel 58.693	29 **Cu** Copper 63.55	30 **Zn** Zinc 65.4	31 **Ga** Gallium 69.723	32 **Ge** Germanium 72.63	33 **As** Arsenic 74.92159	34 **Se** Selenium 78.97	35 **Br** Bromine 79.90	36 **Kr** Krypton 83.80
5	37 **Rb** Rubidium 85.468	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.90584	40 **Zr** Zirconium 91.22	41 **Nb** Niobium 92.90637	42 **Mo** Molybdenum 95.95	43 **Tc** Technetium 96.90636	44 **Ru** Ruthenium 101.1	45 **Rh** Rhodium 102.9055	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.868	48 **Cd** Cadmium 112.41	49 **In** Indium 114.818	50 **Sn** Tin 118.71	51 **Sb** Antimony 121.760	52 **Te** Tellurium 127.6	53 **I** Iodine 126.9045	54 **Xe** Xenon 131.29
6	55 **Cs** Cesium 132.9054520	56 **Ba** Barium 137.33		72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.9479	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.207	76 **Os** Osmium 190.2	77 **Ir** Iridium 192.22	78 **Pt** Platinum 195.08	79 **Au** Gold 196.96657	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.383	82 **Pb** Lead 207	83 **Bi** Bismuth 208.98040	84 **Po** Polonium 208.98243	85 **At** Astatine 209.98715	86 **Rn** Radon 222.01758
7	87 **Fr** Francium 223.01973	88 **Ra** Radium 226.02541		104 **Rf** Rutherfordium 267.122	105 **Db** Dubnium 268.126	106 **Sg** Seaborgium 269.128	107 **Bh** Bohrium 270.133	108 **Hs** Hassium 269.1336	109 **Mt** Meitnerium 277.154	110 **Ds** Darmstadtium 282.166	111 **Rg** Roentgenium 282.169	112 **Cn** Copernicium 286.179	113 **Nh** Nihonium 286.182	114 **Fl** Flerovium 290.192	115 **Mc** Moscovium 290.196	116 **Lv** Livermorium 293.205	117 **Ts** Tennessine 294.211	118 **Og** Oganesson 295.216
				57 **La** Lanthanum 138.9055	58 **Ce** Cerium 140.116	59 **Pr** Praseodymium 140.90766	60 **Nd** Neodymium 144.24	61 **Pm** Promethium 144.91276	62 **Sm** Samarium 150.4	63 **Eu** Europium 151.964	64 **Gd** Gadolinium 157.2	65 **Tb** Terbium 158.92535	66 **Dy** Dysprosium 162.500	67 **Ho** Holmium 164.93033	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93422	70 **Yb** Ytterbium 173.05	71 **Lu** Lutetium 174.9668
				89	90	91	92	93	94	95	96	97	98	99	100	101	102	103

In the periodic table, elements are classified according to their atomic number, which is, in fact, the number of protons and therefore electrons that make up that atom.

We will try to understand how these atoms work and interact, since life is a kind of flow and dance where atoms interact and form the molecules of life.

An atom is the smallest unit of an element and is made up of particles that are rotating.

It has a nucleus made of particles called neutrons and protons and around this nucleus, a bit like the sun, orbit other particles called electrons.

The atom has a mass wich is the sum of protons and neutrons.

Protons are subatomic particles that arbitrarily have a mass of 1 and a positive electric charge, while neutrons have a mass of 1 and a zero electric charge.

Electrons, on the other hand, have negligible mass and do not contribute to the mass of the atom.

However they have a negative electric charge.

In nature all atoms are initially neutral, meaning that the number of protons is equal to the number of electrons.

These electrons, which are particles with a negative electric charge and negligible mass, orbit in spaces according to their energy, called orbitals, and each orbital space can hold a fixed number of electrons.

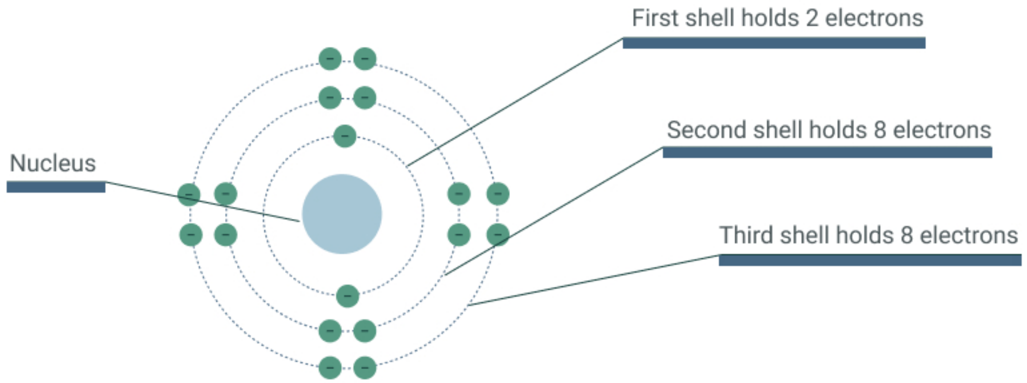
They turn around the nucleus at the speed of 2000 to 2500 kilometers/second for the Hydrogen atom. This speed increases for the heavier elements.

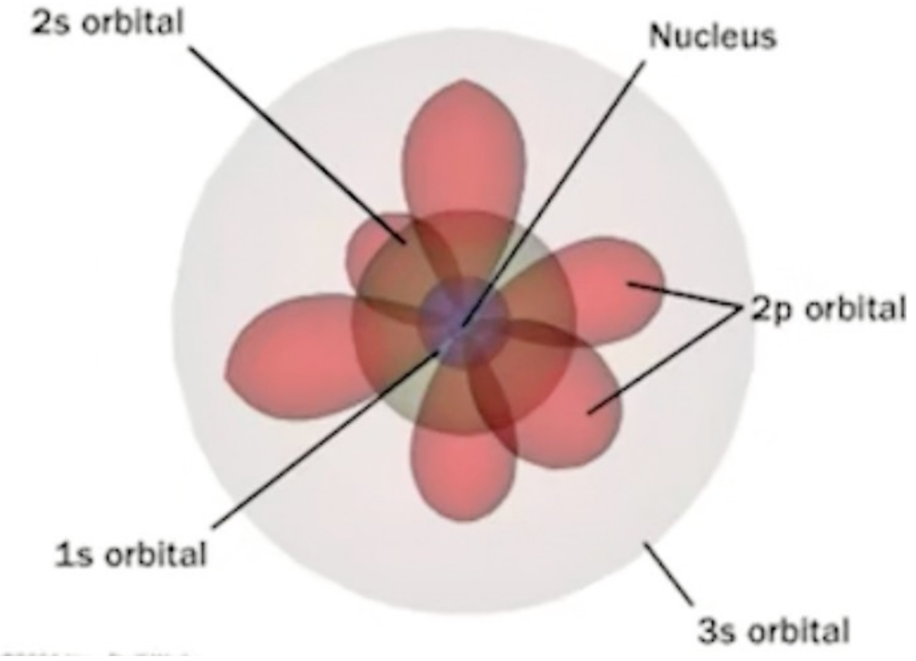
The lowest energy corresponds to the first orbital (or shell), called the 1s orbital, can hold 2 electrons

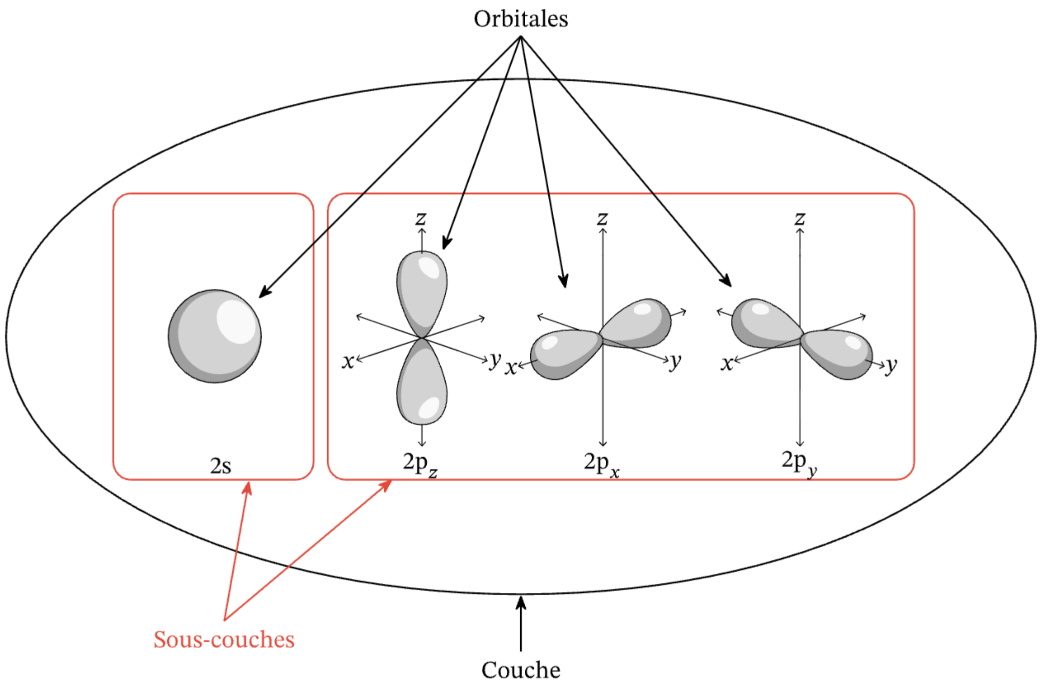
The second energy level, called the higher orbital p, can hold 8 electrons.

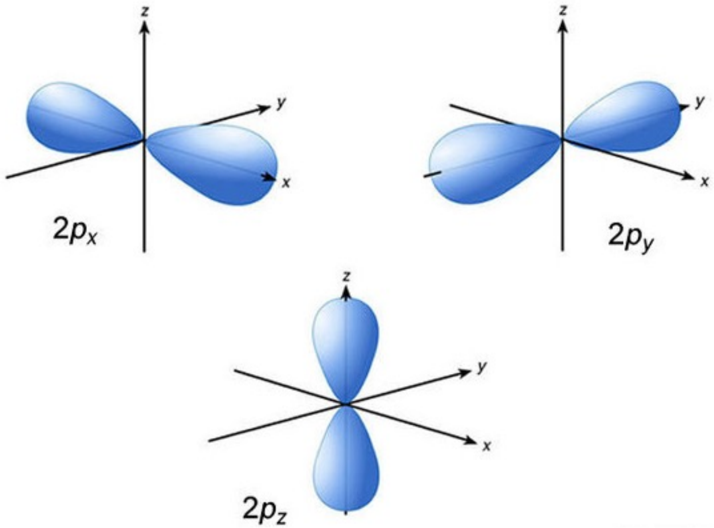
These spaces are not actually linear, but rather volumes in which there is a probability of finding an electron.

Electron Configuration




2s orbital
Nucleus
2p orbital
1s orbital
3s orbital


Orbitales
z
x
y
2s
2p$_z$
2p$_x$
2p$_y$
Sous-couches
Couche


2p$_x$
2p$_y$
2p$_z$
z
y
x

In fact, quantum physics studies the composition of these atoms, proton-neutron made of, and, we will see that the smaller the world, the more matter will ultimately merge with energy.

Finally, we know that an atom is 99% empty space, and particles making up this atom represents only 1%.

The total mass of electrons in a 100 Kg person weighs … only 25 grams.

PERIODIC TABLE OF ELEMENTS

Electron Configuration

Pub Chem

Atomic Number	Symbol	Name	Electron Configuration
17	Cl	Chlorine	[Ne]$3s^{2}3p^{5}$

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 **H** Hydrogen $1s^{1}$																	2 **He** Helium $1s^{2}$
2	3 **Li** Lithium [He]$2s^{1}$	4 **Be** Beryllium [He]$2s^{2}$											5 **B** Boron [He]$2s^{2}2p^{1}$	6 **C** Carbon [He]$2s^{2}2p^{2}$	7 **N** Nitrogen [He]$2s^{2}2p^{3}$	8 **O** Oxygen [He]$2s^{2}2p^{4}$	9 **F** Fluorine [He]$2s^{2}2p^{5}$	10 **Ne** Neon [He]$2s^{2}2p^{6}$
3	11 **Na** Sodium [Ne]$3s^{1}$	12 **Mg** Magnesium [Ne]$3s^{2}$											13 **Al** Aluminum [Ne]$3s^{2}3p^{1}$	14 **Si** Silicon [Ne]$3s^{2}3p^{2}$	15 **P** Phosphorus [Ne]$3s^{2}3p^{3}$	16 **S** Sulfur [Ne]$3s^{2}3p^{4}$	17 **Cl** Chlorine [Ne]$3s^{2}3p^{5}$	18 **Ar** Argon [Ne]$3s^{2}3p^{6}$
4	19 **K** Potassium [Ar]$4s^{1}$	20 **Ca** Calcium [Ar]$4s^{2}$	21 **Sc** Scandium [Ar]$4s^{2}3d^{1}$	22 **Ti** Titanium [Ar]$4s^{2}3d^{2}$	23 **V** Vanadium [Ar]$4s^{2}3d^{3}$	24 **Cr** Chromium [Ar]$3d^{5}4s^{1}$	25 **Mn** Manganese [Ar]$4s^{2}3d^{5}$	26 **Fe** Iron [Ar]$4s^{2}3d^{6}$	27 **Co** Cobalt [Ar]$4s^{2}3d^{7}$	28 **Ni** Nickel [Ar]$4s^{2}3d^{8}$	29 **Cu** Copper [Ar]$4s^{1}3d^{10}$	30 **Zn** Zinc [Ar]$4s^{2}3d^{10}$	31 **Ga** Gallium [Ar]$4s^{2}3d^{10}4p^{1}$	32 **Ge** Germanium [Ar]$4s^{2}3d^{10}4p^{2}$	33 **As** Arsenic [Ar]$4s^{2}3d^{10}4p^{3}$	34 **Se** Selenium [Ar]$4s^{2}3d^{10}4p^{4}$	35 **Br** Bromine [Ar]$4s^{2}3d^{10}4p^{5}$	36 **Kr** Krypton [Ar]$4s^{2}3d^{10}4p^{6}$
5	37 **Rb** Rubidium [Kr]$5s^{1}$	38 **Sr** Strontium [Kr]$5s^{2}$	39 **Y** Yttrium [Kr]$5s^{2}4d^{1}$	40 **Zr** Zirconium [Kr]$5s^{2}4d^{2}$	41 **Nb** Niobium [Kr]$5s^{1}4d^{4}$	42 **Mo** Molybdenum [Kr]$5s^{1}4d^{5}$	43 **Tc** Technetium [Kr]$5s^{2}4d^{5}$	44 **Ru** Ruthenium [Kr]$5s^{1}4d^{7}$	45 **Rh** Rhodium [Kr]$5s^{1}4d^{8}$	46 **Pd** Palladium [Kr]$4d^{10}$	47 **Ag** Silver [Kr]$5s^{1}4d^{10}$	48 **Cd** Cadmium [Kr]$5s^{2}4d^{10}$	49 **In** Indium [Kr]$5s^{2}4d^{10}5p^{1}$	50 **Sn** Tin [Kr]$5s^{2}4d^{10}5p^{2}$	51 **Sb** Antimony [Kr]$5s^{2}4d^{10}5p^{3}$	52 **Te** Tellurium [Kr]$5s^{2}4d^{10}5p^{4}$	53 **I** Iodine [Kr]$5s^{2}4d^{10}5p^{5}$	54 **Xe** Xenon [Kr]$5s^{2}4d^{10}5p^{6}$
6	55 **Cs** Cesium [Xe]$6s^{1}$	56 **Ba** Barium [Xe]$6s^{2}$		72 **Hf** Hafnium [Xe]$6s^{2}4f^{14}5d^{2}$	73 **Ta** Tantalum [Xe]$6s^{2}4f^{14}5d^{3}$	74 **W** Tungsten [Xe]$6s^{2}4f^{14}5d^{4}$	75 **Re** Rhenium [Xe]$6s^{2}4f^{14}5d^{5}$	76 **Os** Osmium [Xe]$6s^{2}4f^{14}5d^{6}$	77 **Ir** Iridium [Xe]$6s^{2}4f^{14}5d^{7}$	78 **Pt** Platinum [Xe]$6s^{1}4f^{14}5d^{9}$	79 **Au** Gold [Xe]$6s^{1}4f^{14}5d^{10}$	80 **Hg** Mercury [Xe]$6s^{2}4f^{14}5d^{10}$	81 **Tl** Thallium [Xe]$6s^{2}4f^{14}5d^{10}$...	82 **Pb** Lead [Xe]$6s^{2}4f^{14}5d^{10}$...	83 **Bi** Bismuth [Xe]$6s^{2}4f^{14}5d^{10}$...	84 **Po** Polonium [Xe]$6s^{2}4f^{14}5d^{10}$...	85 **At** Astatine [Xe]$6s^{2}4f^{14}5d^{10}$...	86 **Rn** Radon [Xe]$6s^{2}4f^{14}5d^{10}$...
7	87 **Fr** Francium [Rn]$7s^{1}$	88 **Ra** Radium [Rn]$7s^{2}$		104 **Rf** Rutherfordium [Rn]$7s^{2}5f^{14}6d^{2}$	105 **Db** Dubnium [Rn]$7s^{2}5f^{14}6d^{3}$	106 **Sg** Seaborgium [Rn]$7s^{2}5f^{14}6d^{4}$	107 **Bh** Bohrium [Rn]$7s^{2}5f^{14}6d^{5}$	108 **Hs** Hassium [Rn]$7s^{2}5f^{14}6d^{6}$	109 **Mt** Meitnerium [Rn]$7s^{2}5f^{14}6d^{7}$	110 **Ds** Darmstadtium [Rn]$7s^{2}5f^{14}6d^{8}$	111 **Rg** Roentgenium [Rn]$7s^{2}5f^{14}6d^{9}$	112 **Cn** Copernicium [Rn]$7s^{2}5f^{14}6d^{10}$	113 **Nh** Nihonium [Rn]$5f^{14}6d^{10}7s^{2}$...	114 **Fl** Flerovium [Rn]$7s^{2}7p^{2}5f^{14}6$...	115 **Mc** Moscovium [Rn]$7s^{2}7p^{3}5f^{14}6$...	116 **Lv** Livermorium [Rn]$7s^{2}7p^{4}5f^{14}6$...	117 **Ts** Tennessine [Rn]$7s^{2}7p^{5}5f^{14}6$...	118 **Og** Oganesson [Rn]$7s^{2}7p^{6}5f^{14}6$...
				57 **La** Lanthanum [Xe]$6s^{2}5d^{1}$	58 **Ce** Cerium [Xe]$6s^{2}4f^{1}5d^{1}$	59 **Pr** Praseodymium [Xe]$6s^{2}4f^{3}$	60 **Nd** Neodymium [Xe]$6s^{2}4f^{4}$	61 **Pm** Promethium [Xe]$6s^{2}4f^{5}$	62 **Sm** Samarium [Xe]$6s^{2}4f^{6}$	63 **Eu** Europium [Xe]$6s^{2}4f^{7}$	64 **Gd** Gadolinium [Xe]$6s^{2}4f^{7}5d^{1}$	65 **Tb** Terbium [Xe]$6s^{2}4f^{9}$	66 **Dy** Dysprosium [Xe]$6s^{2}4f^{10}$	67 **Ho** Holmium [Xe]$6s^{2}4f^{11}$	68 **Er** Erbium [Xe]$6s^{2}4f^{12}$	69 **Tm** Thulium [Xe]$6s^{2}4f^{13}$	70 **Yb** Ytterbium [Xe]$6s^{2}4f^{14}$	71 **Lu** Lutetium [Xe]$6s^{2}4f^{14}5d^{1}$
				89 **Ac** Actinium [Rn]$7s^{2}6d^{1}$	90 **Th** Thorium [Rn]$7s^{2}6d^{2}$	91 **Pa** Protactinium [Rn]$7s^{2}5f^{2}6d^{1}$	92 **U** Uranium [Rn]$7s^{2}5f^{3}6d^{1}$	93 **Np** Neptunium [Rn]$7s^{2}5f^{4}6d^{1}$	94 **Pu** Plutonium [Rn]$7s^{2}5f^{6}$	95 **Am** Americium [Rn]$7s^{2}5f^{7}$	96 **Cm** Curium [Rn]$7s^{2}5f^{7}6d^{1}$	97 **Bk** Berkelium [Rn]$7s^{2}5f^{9}$	98 **Cf** Californium [Rn]$7s^{2}5f^{10}$	99 **Es** Einsteinium [Rn]$7s^{2}5f^{11}$	100 **Fm** Fermium [Rn]$5f^{12}7s^{2}$	101 **Md** Mendelevium [Rn]$7s^{2}5f^{13}$	102 **No** Nobelium [Rn]$7s^{2}5f^{14}$	103 **Lr** Lawrencium [Rn]$7s^{2}5f^{14}6d^{1}$

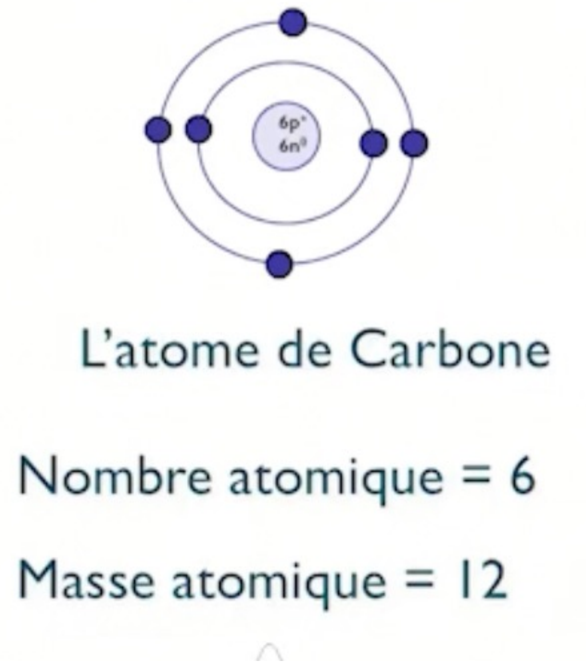
Atoms, therefore, are characterized by a number of protons that determines their identity.

For example, here you have a carbon atom which, in fact, has an atomic number of 6, meaning it has 6 protons.

It has an atomic mass of 12, meaning it has 12 units, and therefore, since it only has 6 protons, it has 6 neutrons.

And it also has 6 electrons.

These 6 electrons will be distributed in these spaces called orbitals.



When an orbital has a specific number of electrons occupied, for example, 2 electrons, we say that the orbital is saturated.

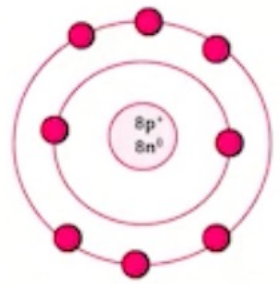
When it's missing an electron, we say that it's unsaturated.

Here, you see, for example, that a carbon atom has 4 electrons that could be added to fill its orbitals.

Oxygen has an atomic number of 8 and an atomic mass of 16

There are 8 electrons and 8 neutrons, since its atomic mass is twice the number of protons.

So here, once we build and place the electrons in the orbitals, we see that there will be a first, low-energy 1s orbital that will be saturated, and then we will have the 6 electrons that will occupy the orbitals.



There is rule in physics according to which that the atom will always try to saturate its outermost electron orbitals, because that's how it will be able to achieve a certain stability.

An atom's primary goal is to fill its outermost electron orbital.

Life, throughout evolution, has chosen to build living organisms.

Interestingly, we see that the predominant element is hydrogen, followed by carbon and nitrogen.

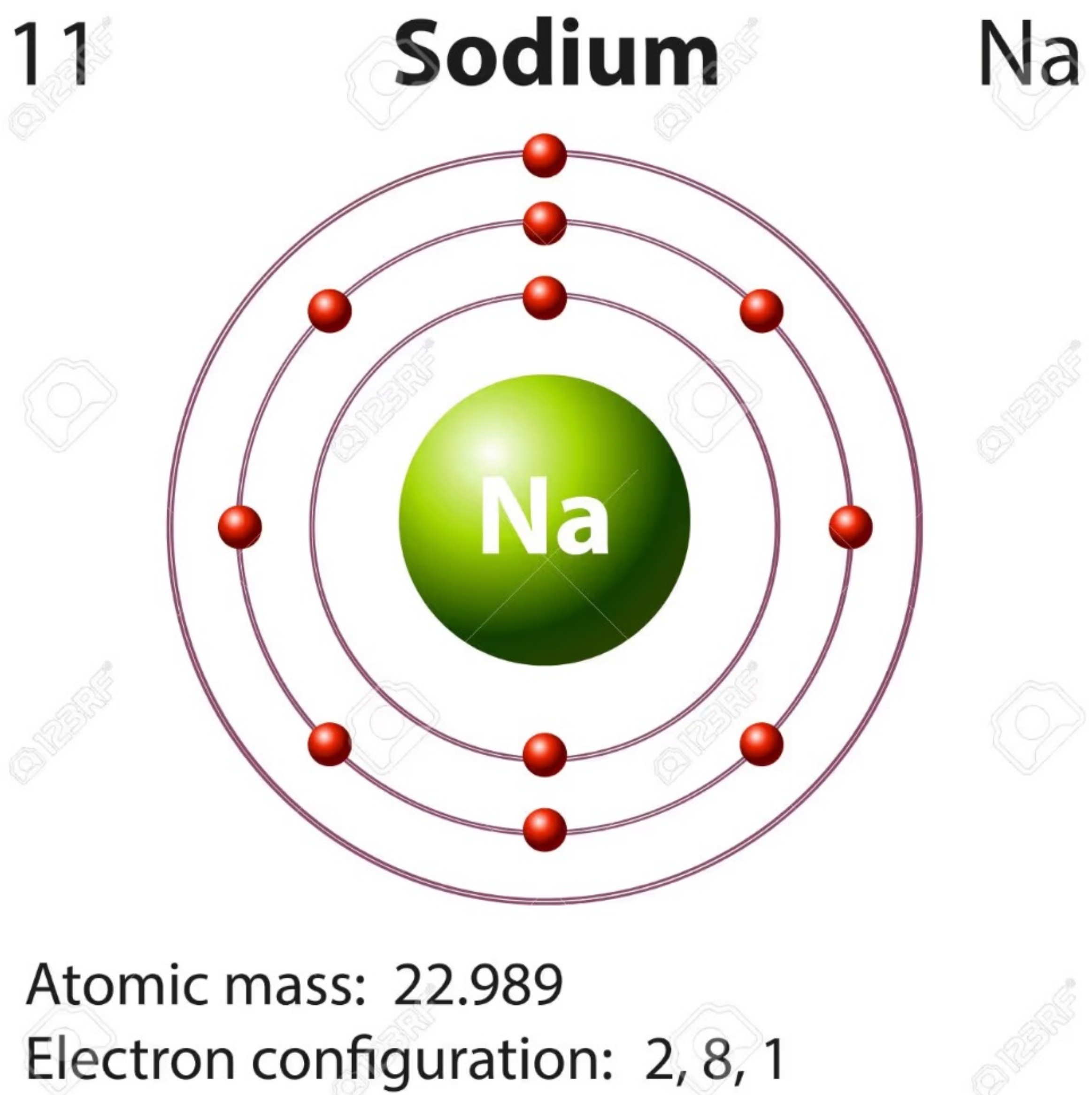
These are elements with relatively low atomic numbers.

Hydrogen atom has an atomic number of 1, meaning it has one proton, not a neutron. (If it had a neutron, it would have an atomic mass of 2). It also has one electron.

Its electron orbital, the 1s orbital, is missing one electron to be fully saturated.

Ultimately, hydrogen isn't quite at its maximum capacity because looking at the saturation of outer electron orbitals, it needs to gain an electron.

Then you have helium, which is an ideal gas; it's perfectly stable and doesn't need anything else.


11
Sodium
Na
Na
Atomic mass: 22.989
Electron configuration: 2, 8, 1

Lets look at the sodium, which is one of the most abundant minerals in our tissues. It has an atomic number of 11 and it has saturated its first orbital, the second is saturated, and then it has a miserable lone electron orbiting in that orbital, which makes this atom rather unhappy, since it doesn't have that state of electron orbital saturation.

And then there's chlorine, which has an atomic number of 17: it's missing an electron to fill its third orbital, and it will spend its life trying to fill this gap to reach that optimal equilibrium state.

The atom's motivation to try to fill and saturate its outermost electron orbital gives it a force called « electronegativity ».

H **2,1**							He 0
Li 1,0	Be 1,5	B 2,0	**C** **2,5**	N 3,0	**O** **3,5**	F 4,0	Ne 0
Na 0,9	Mg 1,2	Al 1,5	Si 1,8	P 2,1	S 2,5	Cl 3,0	Ar 0

When an atom tries to complete its electron orbital by gaining an electron, we say that it will be reduced. So reduction is the gain of an electron.

When it loses an electron, (remember sodium), it will be oxidized.

Oxidation is the loss of an electron, and reduction is the gain of an electron.

Oxygen is the atom that is the biggest electron thief and has the strongest oxidizing power.

That's why we call this process of electron loss oxidation zas oxygen is primarily involved in the loss of electrons through oxidation.

Oxygen has an electronegativity of 3.5, and we'll see that it's the most abundant atom, one of the most abundant atoms in organic matter

Fluorine has a higher electronegativity, but its proportion is small in organic matter, so ultimately it is **oxygen that is the number one electron thief, the most important oxidant.**

Hydrogen, on the other hand, has a medium electronegativity because it can either lose its electron in a somewhat ambiguous situation, and carbon has an electronegativity of 2.5.

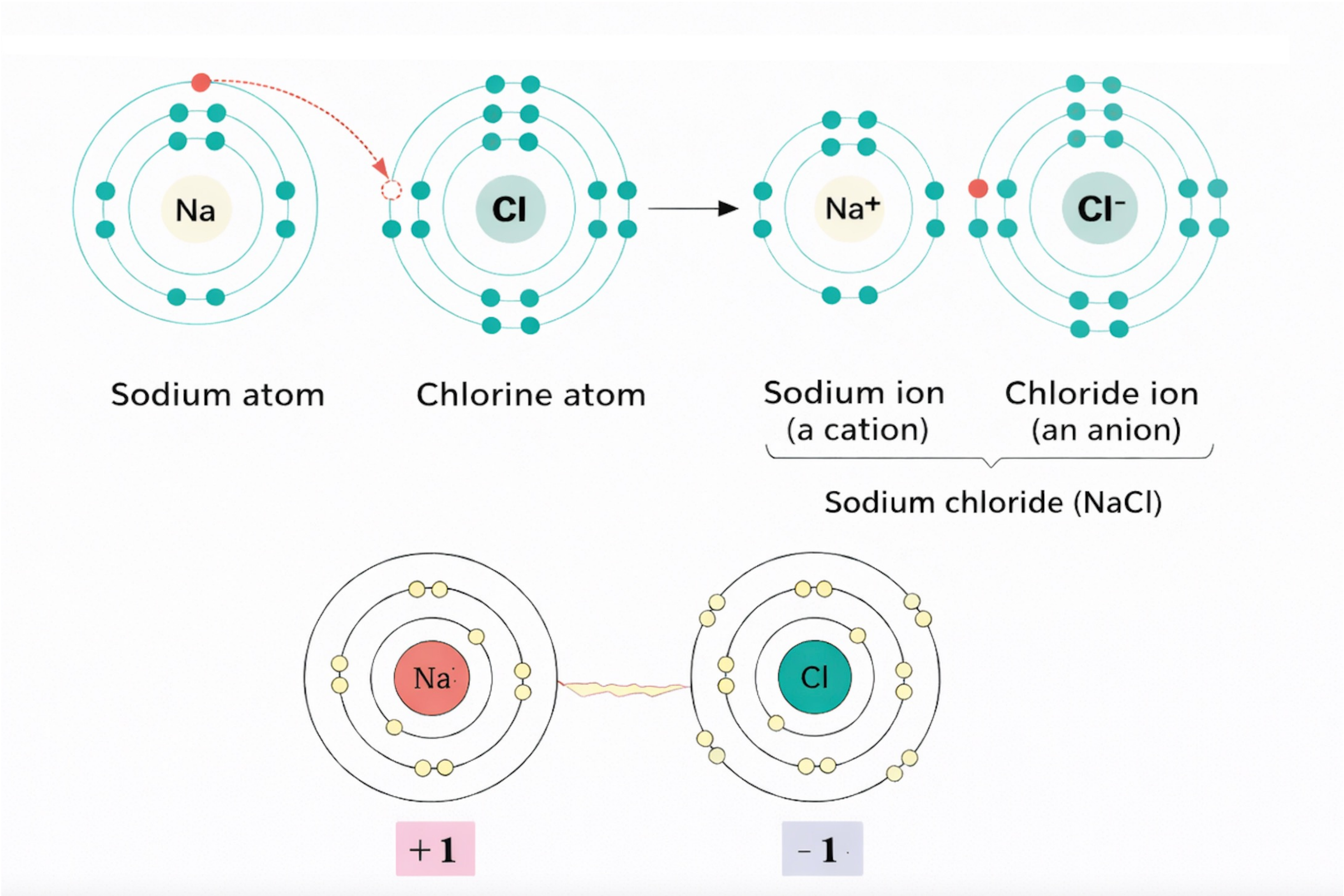
Ultimately, the electronegativity of hydrogen and carbon is considered so close that they have a more or less equivalent strength

This leads you to the fact that in the universe, and particularly in living organisms, these atoms will always try to fill their outermost electron orbital, either to fly or to form bonds between atoms to create molecules.

These bonds that form between atoms in these kinds of atomic associations will have certain strengths; they are the basis of chemical reactions and will create what we call chemical bonds.

And there are 4 types of chemical bonds that will contribute to the construction of matter.

In order of strength of attraction between atoms, we have ionic bonds, covalent bonds, hydrogen bonds, and Van der Waal forces


Na
Cl
Na+
Cl⁻
Sodium atom
Chlorine atom
Sodium ion
(a cation)
Chloride ion
(an anion)
Sodium chloride (NaCl)
Na
Cl
+1
-1

Here is a ionic bond, which is the strongest bond, and on this slide, you see, we have sodium with an isolated electron all alone in the outermost electron orbital of level 3.

And when it meets chlorine, which has a somewhat contradictory situation, quickly there is a « negotiation » that takes place.

Sodium, in fact, only has one electron, while chlorine gains one. Their difference in electronegativity is such that the electron will be completely stolen by the chlorine.

Chlorine, now with an extra electron, will have a completely negative charge. Since it initially had 17 protons and 17 electrons, it now has 18 electrons, becoming an ion, which we call a negatively charged anion.

Sodium, which had 11 protons and 11 electrons, loses an electron, leaving it with only 10 electrons. It will have a positive charge, and will therefore be a cation, a positive ion.

These differences in electrical charge cause them to attract each other very closely, forming a very strong bond, called an ionic bond

In biology, we speak of emergence, meaning that the association of two subunits will give a new compound that no longer has the properties of the elements that constitute it.

Let's look at the hydrogen atom forming the hydrogen gas molecule, which will have different properties.

Covalent bonds

When two hydrogen atoms meet, they are looking to either gain or donate an electron.

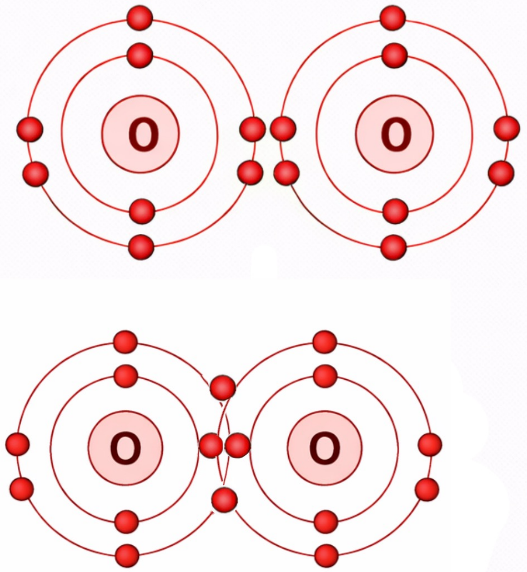
But when they are together, they decide to "partner" their two electrons, meaning they share them, creating an orbital that encompasses both protons.

And then, since both hydrogens have the same electronegativity, the electrons will be orbiting either a proton or the other hydrogen atom an equal number of times

And so here, the two hydrogen atoms will be joined by what is called a simple covalent bond, which will not be polarized, because the electron is shared in a balanced, equitable way between the two nuclei which are protons.

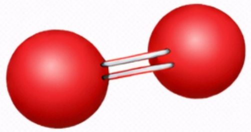
The situation is similar with oxygen, except that under these conditions, each oxygen atom needs two additional electrons to complete its outermost electron orbital.

And since each is missing two electrons, they will combine. This will give rise to dioxygen, the oxygen molecule, which will play such a crucial role in the history of life on planet Earth.



O = O

Liaison covalente
double



Since they have the same electronegativity, there will still behalf the time when an atom has its orbital filled, the other half, it will be missing, in fact, not two, but four.

So ultimately, oxygen, if it has the opportunity, will try to form other interactions and fill its electron orbitals more stably and permanently.

We have a nonpolar covalent double bond as both atoms have the same electronegativity.

But when an oxygen molecule encounters hydrogen atoms, the scenario will be a little different.

Oxygen, as you know, has an extremely high electronegativity, 3.1, while hydrogen has a much lower one, 2.1.

The oxygen atom will say to the hydrogens : « listen, we propose that you each share your electron with us, and you will sometimes have the impression of having two electrons, and we will have the impression of having eight electrons in the outermost electron orbital ».

The hydrogen atoms are attracted to this proposal and indeed share their electron.

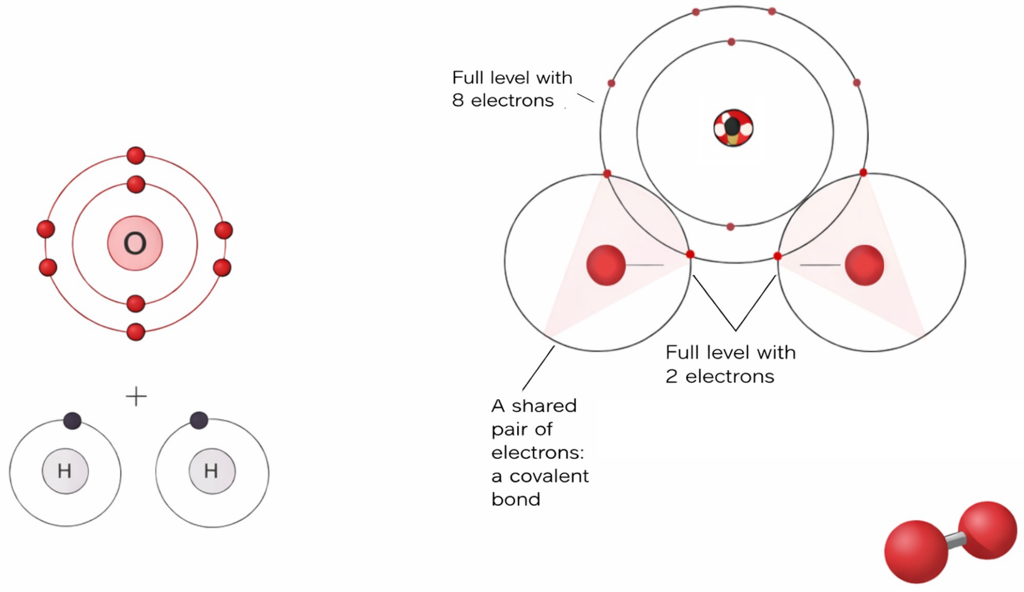
What they hadn't considered was the difference in electronegativity, because oxygen, being much stronger, will attract hydrogen much more often to its nucleus than hydrogen attracts it.

This means that the nuclei of hydrogen atoms are most often without any electrons, and thus have an electric charge,.

Due to the difference in electronegativity, we see that the electron of the hydrogen atom will spend much more time in the outer electron orbital of the oxygen atom, and this will create a polarization, that is to say, a proportional difference in the presence of electrons around the atom of the oxygen nucleus compared to the hydrogen atom.

The nuclei of hydrogen atoms are most often without any electrons, and thus they have an electrical charge.

This molecular configuration of water, which creates an electric dipole with two partial negative charges represented by delta-minus and one partial positive charge by delta-plus, gives water exceptional properties.



Due to this polarization of these partial electric charges, water molecules are always associated by electrical attraction.

These attractions are called hydrogen bonds, even though they involve oxygen.

These are weak bonds that last only 10^{-12} seconds: they are extremely fleeting.

Van der Wals forces

The last type of bond does not involve electrical charges, nor the need to fill electron orbitals, but rather micro-gravitational forces known as Van der Waals forces.

These are forces that are related to the distance between atoms, and this micro-gravitational attraction force will depend on the size and density of these atoms.

What is important to understand at this stage is that this life will involve the management of electrons.

Electrons are subatomic entities with negligible mass, but they have a negative electrical charge and are endowed with energy.

And ultimately, it's through this energy carried by electrons that chemical reactions will be able to occur in relation to life

Pr. Szent-Györgyi, who actually holds a Nobel Prize in Physiology and has done a lot of work on ATP, said :

Life is nothing more than an electron trying to find a place where it can rest."

So, an electron will, in fact, try to find its place in an orbital.

And we could say, moreover, that finding its place in an atom will lead to stability

Ultimately, we can summarize life as a ballet of electrons, where each electron tries to find its place.

This electron lives in orbitals, and the closer it is to the nucleus, the more stable it is.

If we want to make it change orbitals, we need to give it energy, which can come from different sources.

To move to a higher orbital, it must have the exact amount of energy, no more and no less, that corresponds to the second energy level of its orbital.

If it doesn't have this exact amount of energy, the electron remains in its current orbital.

When an electron jumps from one orbital to another, it will have more energy, but it will always tend to be closer to the nucleus, and therefore it will fall back down, releasing the energy it received to ascend to higher orbital levels.

And this movement from low to high energy level orbitals is the basis of chemical reactions, but also of electrical reactions, and so on.

Electrons are ultimately the vehicles of energy. **All energy flows pass through electrons.**

But electrons can enter unstable states when they become too energetic.

These high-energy electrons, which pass from one atom to another, from one molecule to another, must be protected, transported by entities that not only retain the energy but also protect the electron from being captured by an atom that might try to seize it.

And so, very quickly, during evolution, electron carriers developed

One of the first and most important for your health is a transporter called NAD, for Nicotinamide Dinucleotide, which carries high-energy electrons from one place to another.

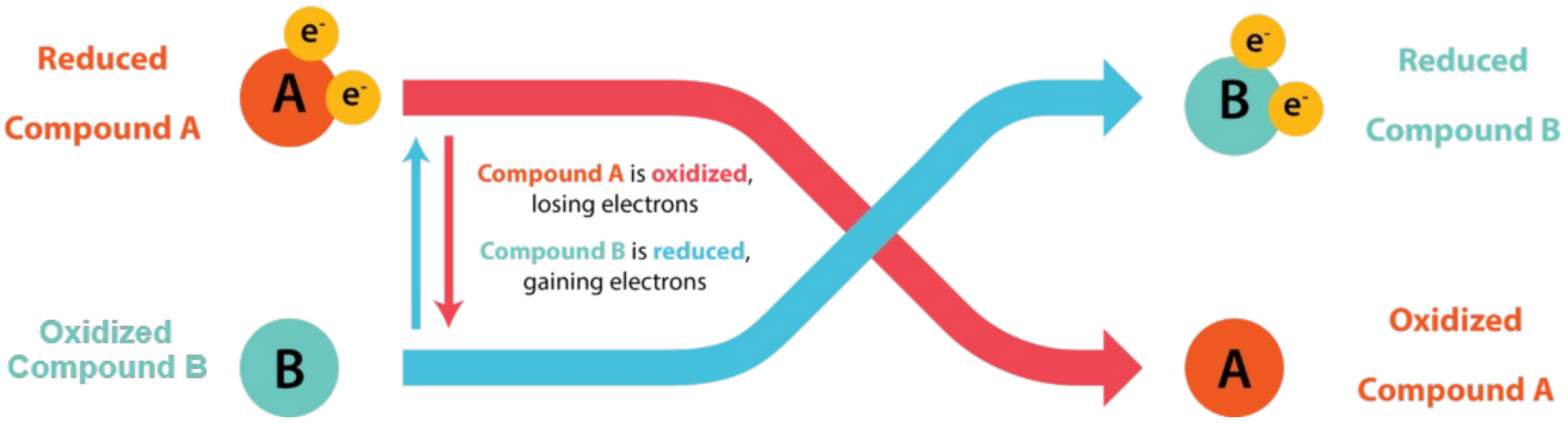
It's built from a precursor vitamin, a molecule that we humans can't synthesize: niacin.

Niacin is one of the most important vitamins, so let's get down to specifics.

Oxidation consists of a loss of electrons, and in biological systems, oxygen is the most frequent electron acceptor due to its strong attraction to electrons.

Reduction, on the other hand, is a gain of electrons. The reduced form of a molecule has a higher energy level than its oxidized form.

REDOX


Reduced
Compound A
A
e-
e-
Compound A is oxidized,
losing electrons
Compound B is reduced,
gaining electrons
Oxidized
Compound B
B
B
e-
e-
Reduced
Compound B
A
Oxidized
Compound A

We could say it is an oxydant, since it is capable of capturing « hot electrons ».

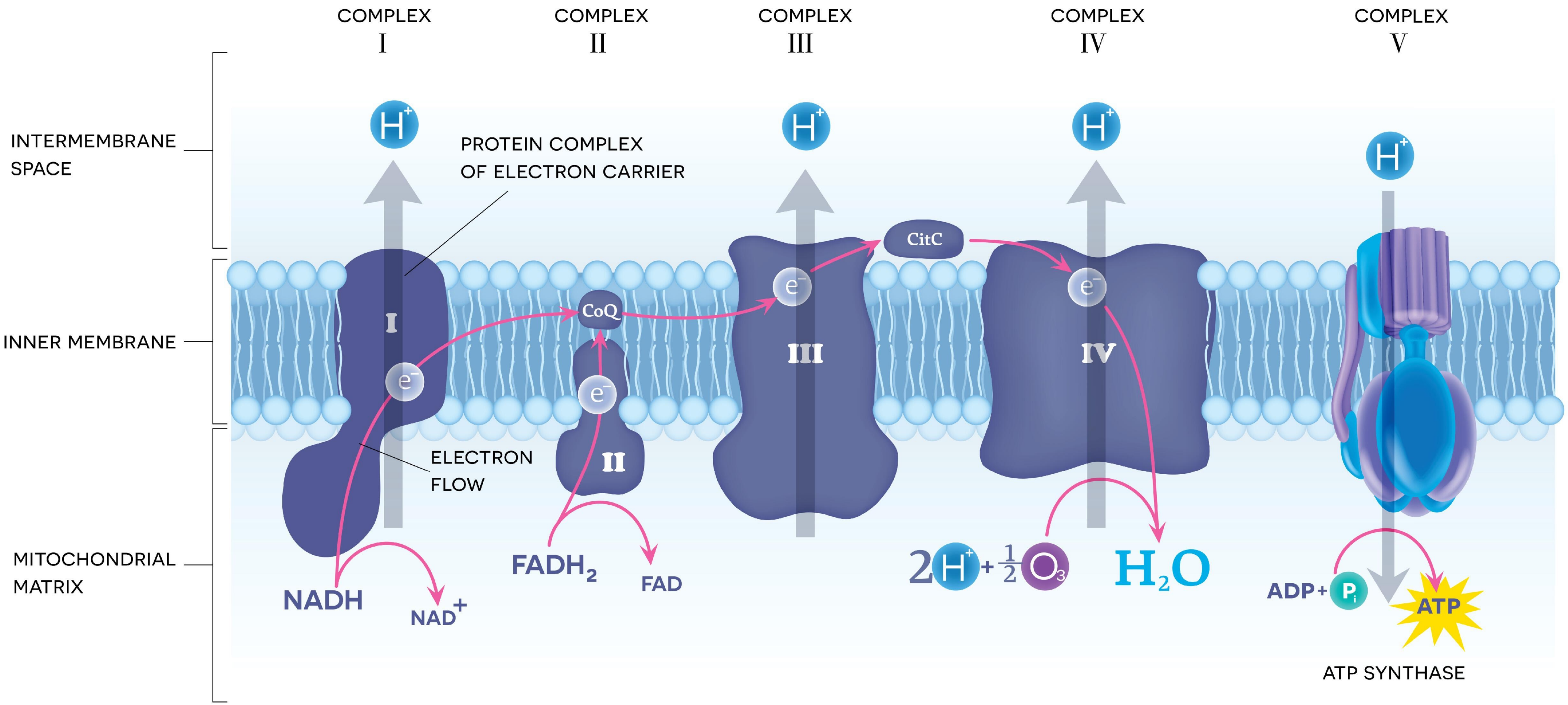
And this component will donate its electrons elsewhere, acting as a reducing agent.

NAD will spend its life either charged or uncharged with electrons.

When charged with electrons, it is reduced. When it loses electrons, it is oxidized

A daily intake of vitamin B3 is essential to ensure the production of these electron transporters, which play a fundamental role in our health.

ELECTRON TRANSPORT CHAIN



FAD is a carrier that will tend to acquire « lower-temperature » or « lower energy » electrons, which are somewhat neglected by NAD, which is designed only to transport extremely « hot » electrons.

To produce this FAD, we need vitamin B2, Riboflavin (vitamin B1).

Vitamin B1 doesn't accumulate. It needs to be taken daily to ensure this metabolism.

And this FAD will also play an extremely important role.

Energy is defined as the capacity to do work, and heat is the simplest way to measure it (calories), since all forms of energy are convertible into heat.

Potential energy is stored energy.

In every organism, the potential energy present in certain molecules can be transferred to other molecules and stored in various chemical bonds, or converted into other forms of energy (kinetic, light, electrical, mechanical).

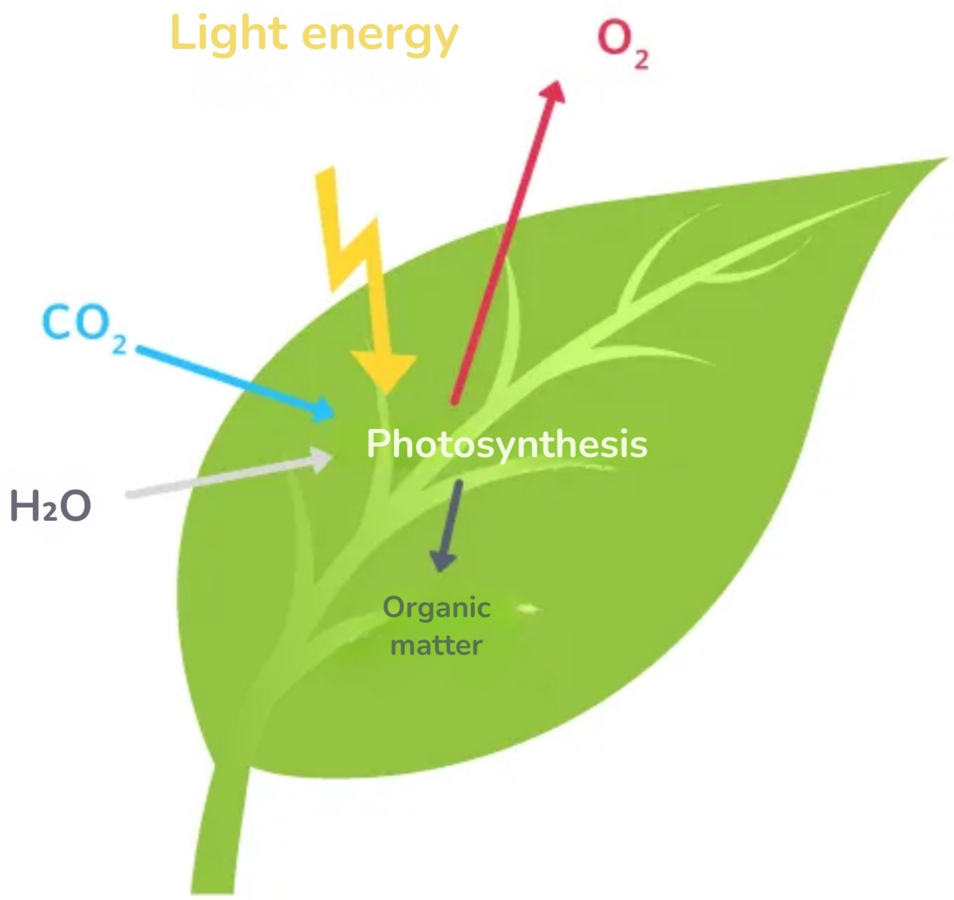
The chemical bonds linking the atoms of a molecule constitute modes of energy storage and **reduce the entropy of the system.**

The strength of these bonds is measured by the energy required to break them.

Plants are the only living beings capable of producing order from disorder, that is, of producing and storing energy from mineral elements through the process of photosynthesis.

Photosynthesis uses light energy from the sun to, on the one hand, "assimilate" carbon and oxygen from carbon dioxide, and on the other hand, extract hydrogen from water to capture its energy.

(A. Tremollières)



Photosynthesis, using only hydrogen from water, releases oxygen into the atmosphere. (A. Trémolières)

Animals consume these plants and recover the energy stored by photosynthesis, which is necessary for their metabolism.

The continuation of life is the result of food absorption, the purpose of which is to produce energy, which allows the organism to compensate for its energy depletion.

This is done through **the synthesis of ATP**.

The cellular respiration is the process of producing ATP from O_2 and Hydrogens in all cells of the body.

At the cellular level, energy supply comes primarily from chemical reactions.

Within the living world, the energy available to perform work decreases as it is dissipated as heat.

Our lives depend on the essential interaction between hydrogen and oxygen: this explosive, thermonuclear reaction takes place at 37°C in the smallest of our cells, where tissue respiration concludes, after releasing and storing a significant amount of energy, with the formation of a water molecule.

This interaction occurs within the mitochondria, the cell's true powerhouse.

Brain and heart are the organs with the greatest amount of mitochondrias, as there are the organs producing a great amount of ATP permanently, as the life maintenance relies on their perfect functioning.

The heart contraction is relying on the ATP produced in the heart cells, where the mitochondrial volume represent 1/3 of the total cardiomyocyte.

This complex process of tissue respiration brings together hydrogen from catabolism and highly reactive oxygen from pulmonary respiration, and this encounter is explosive.

Instead, a whole series of mechanisms are put in place to release this energy gradually, culminating in the formation of a water molecule and the release of 36 ATP molecules, the energy fuel of life, so that they can be captured and used.

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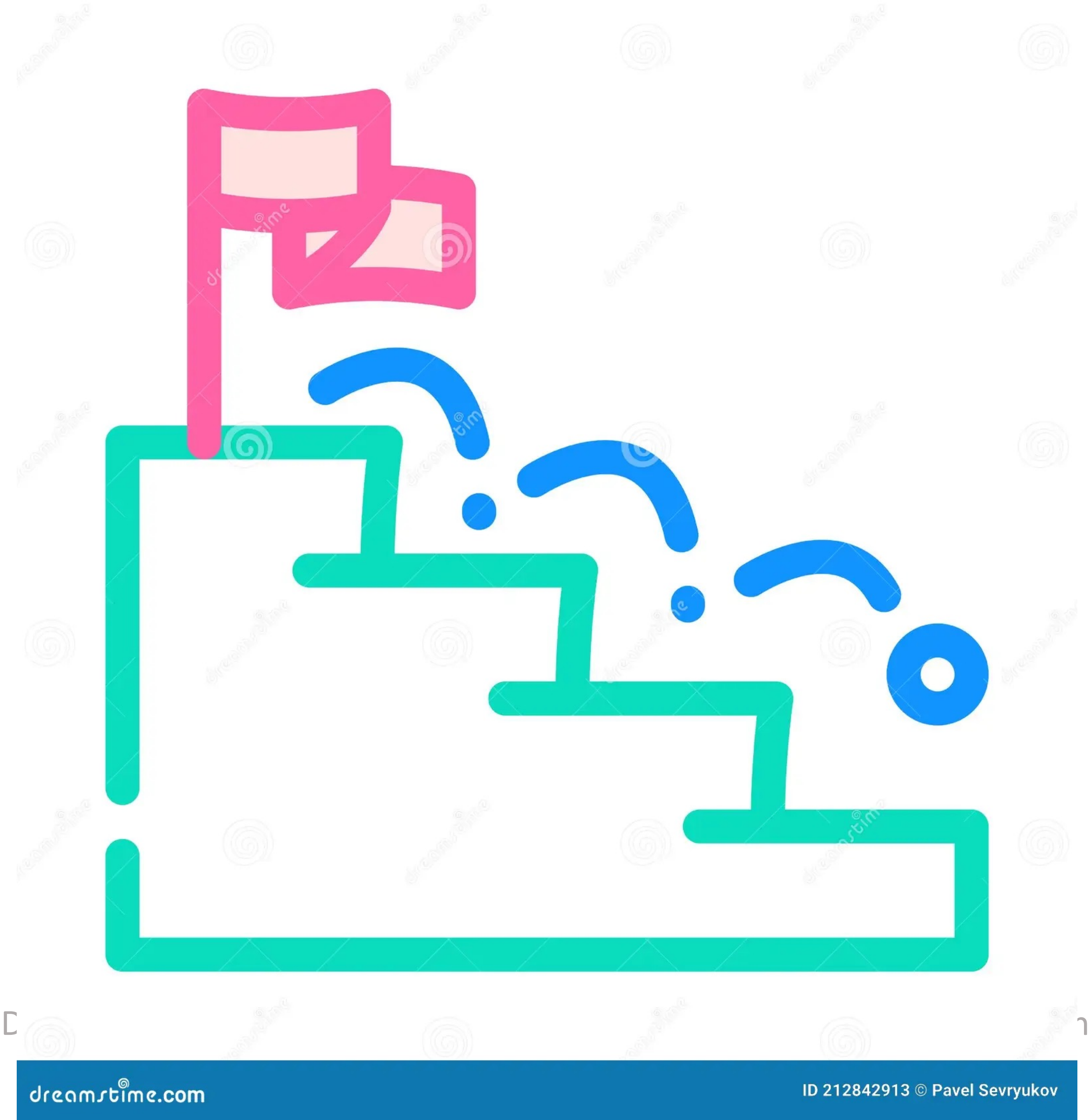
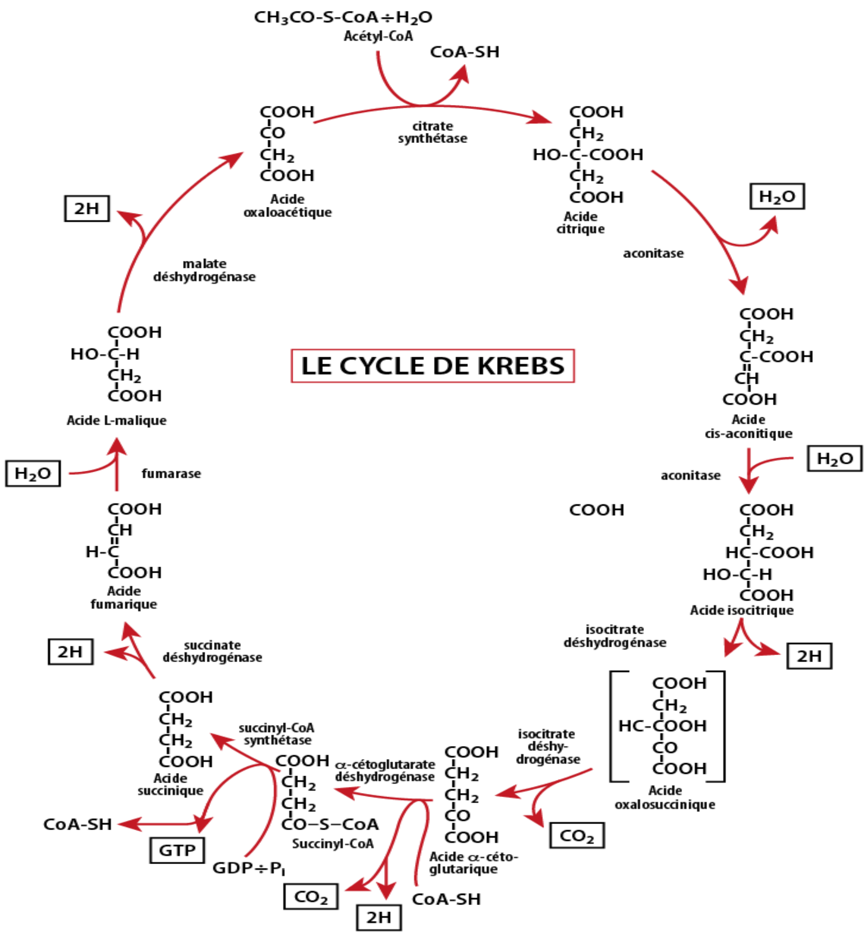
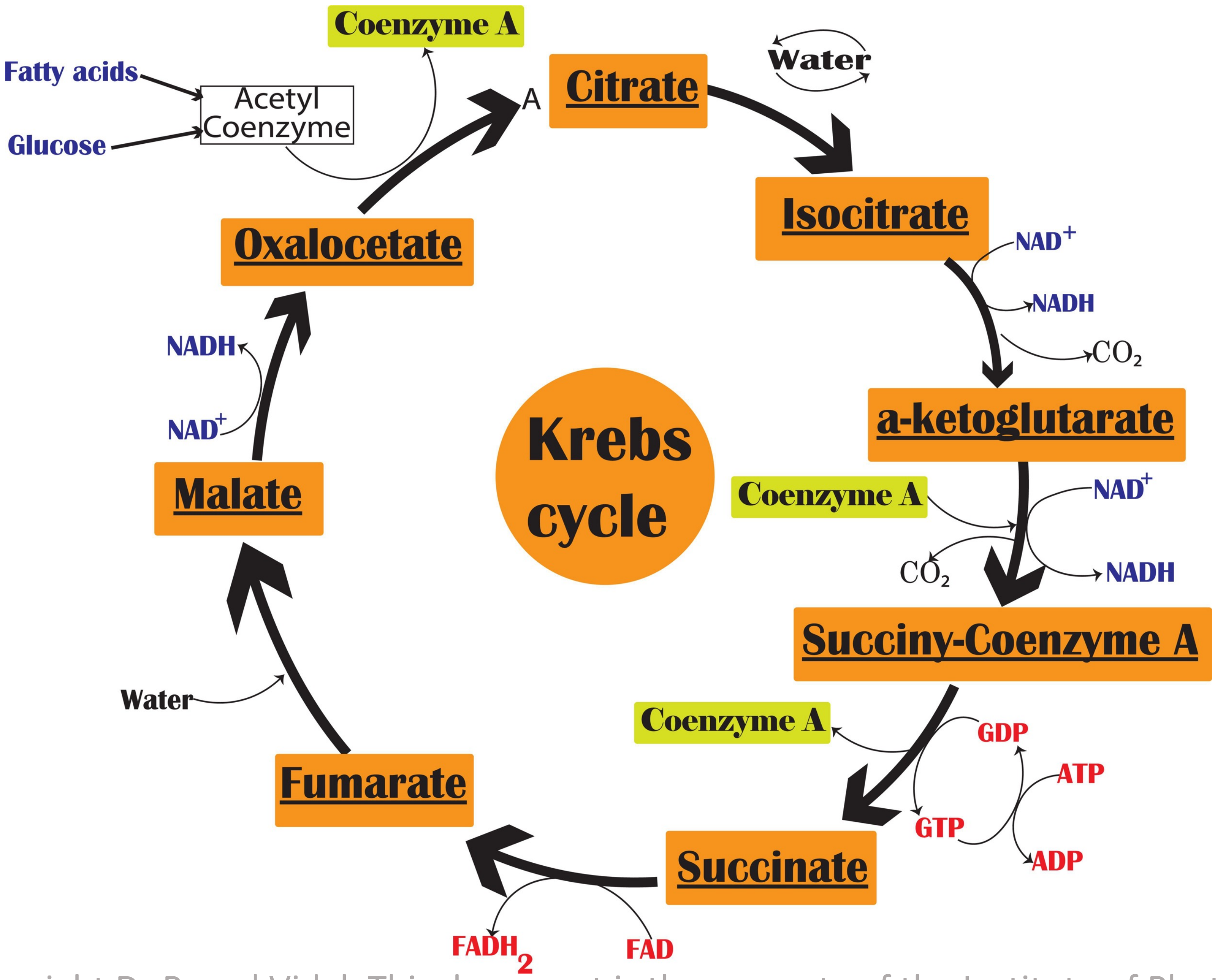
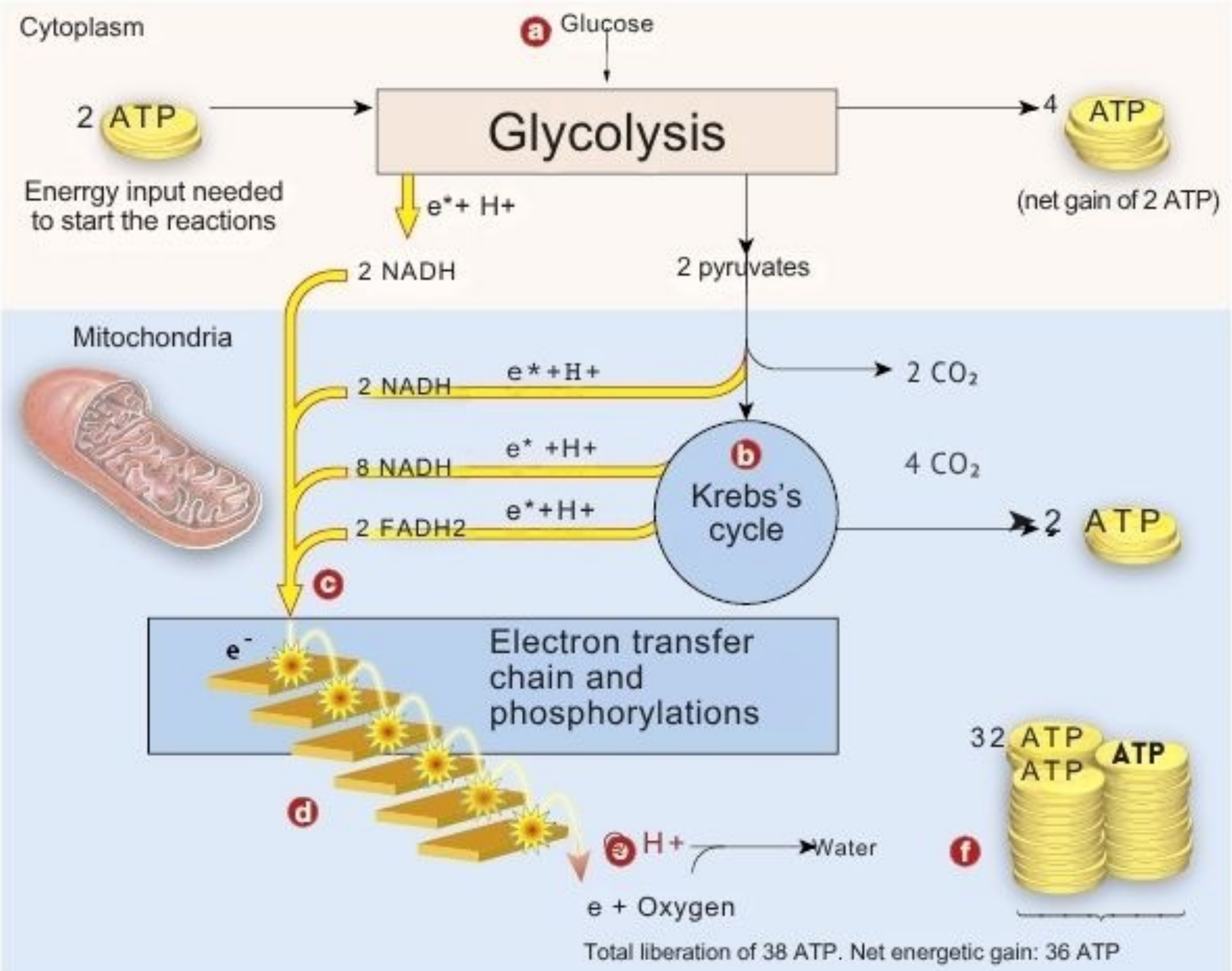


nomedicine


LE CYCLE DE KREBS
CH3CO-S-CoA+H2O
Acétyl-CoA
CoA-SH
citrate synthétase
Acide oxaloacétique
Acide citrique
H2O
aconitase
Acide cis-aconitique
H2O
aconitase
Acide isocitrique
isocitrate déshydrogénase
2H
Acide oxalosuccinique
isocitrate déshy-drogénase
CO2
Acide α-céto-glutarique
α-cétoglutarate déshydrogénase
CoA-SH
2H
CO2
Succinyl-CoA
succinyl-CoA synthétase
GDP+Pi
GTP
CoA-SH
Acide succinique
succinate déshydrogénase
2H
Acide fumarique
fumarase
H2O
Acide L-malique
malate déshydrogénase
2H


Coenzyme A
Fatty acids
Glucose
Acetyl Coenzyme A
Citrate
Water
Isocitrate
NAD+
NADH
CO2
a-ketoglutarate
Coenzyme A
NAD+
CO2
NADH
Succiny-Coenzyme A
Coenzyme A
GDP
ATP
GTP
ADP
Succinate
FADH2
FAD
Fumarate
Water
Malate
NADH
NAD+
Oxalocetate
Krebs cycle



Overall view of aerobic respiration

These reactions start in the cytoplasm, but end inside the mitochondrias :

(a) During the first step, the glycolysis, enzymes breakdown partially glucose into pyruvate.

(b) In the second step, enzymes break down pyruvate land release acetates by venting CO_2.

(c) Then, there is an hydrogen transfer by NAD and FAD allowing to release electrons.

(d) Then, there is an electron transfer with the electron transport chain leading these electrons to an activated oxygen (thanks for example to the Warburg's red ferment).

(e) This allows this natural phenomenon transforming the respiration into an hydric fermentation by the formation of water. (Dean Magnin's theory).

NB : **the second and following steps can only happen in aerobic conditions**, and

The full cellular respiration last few milliseconds.

In the respiratory chain, electron transfer and ATP production (oxidative phosphorylation) are almost instantaneous.

In summary, cellular respiration is not a slow process; it is a "continuous fire" that releases energy almost instantaneously.

In humans, the average energy expenditure of an individual is approximately 8360 kJ (2000 kcal) per 24 hours.

The efficiency of ATP synthesis is around 50%, with the remainder lost as heat. Therefore, approximately 4180 kJ (1000 kcal) are temporarily stored in ATP molecules and then used by cells.

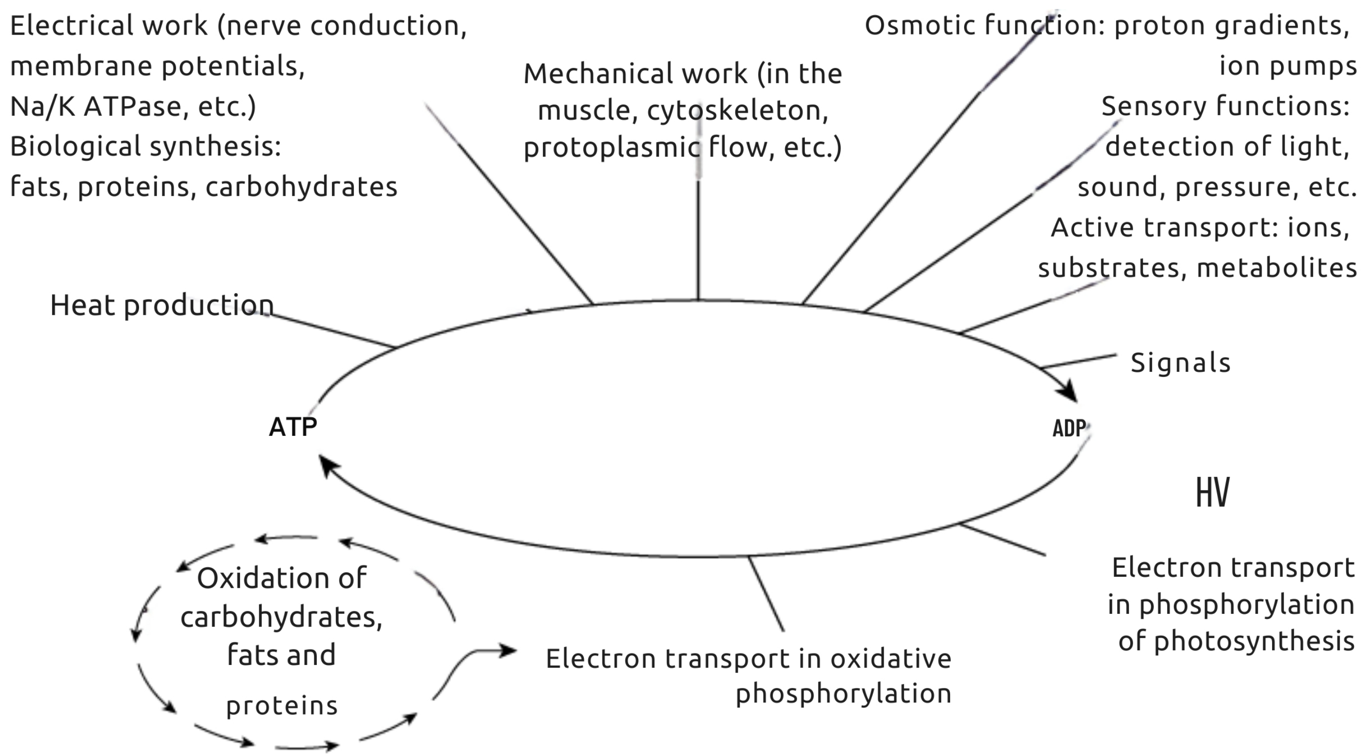
The hydrolysis of one mole of ATP yields 30.5 kJ (7.3 kcal) under standard conditions. The 4180 kJ supplied to cells thus corresponds to the hydrolysis of 83.6 moles of ATP, or approximately 46 kgof ATP.

Given that the ATP/ADP stock for the whole body is about 0.1 mole (around 50 g), this implies that it is renewed 920 times per day, or approximately once every 1.5 minutes.

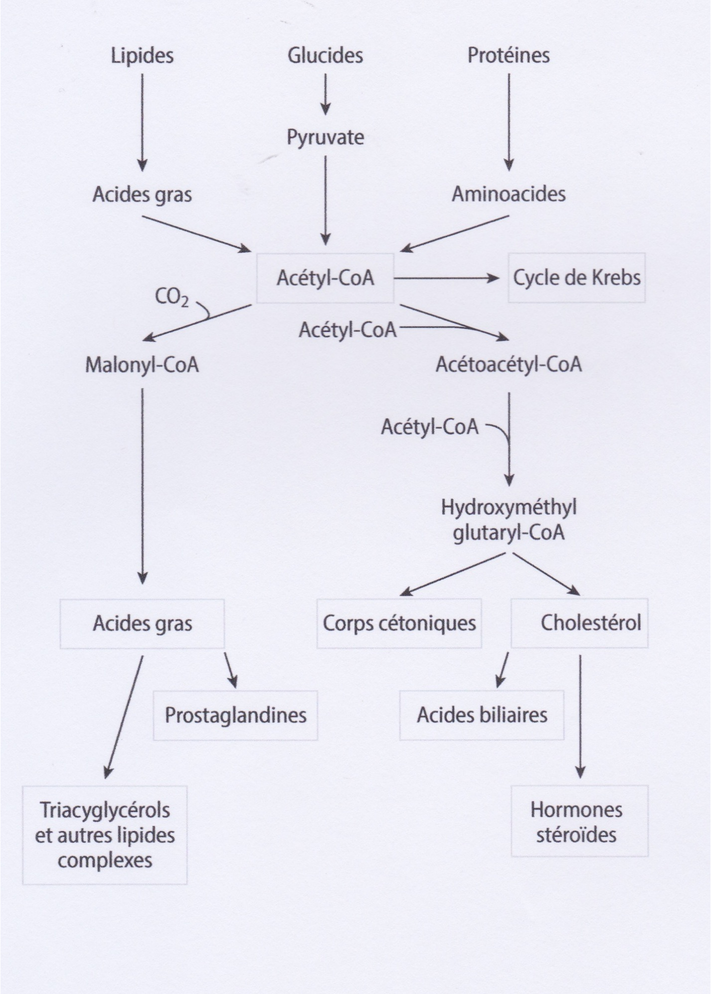
"The most characteristic functions of life are energy transformations during which chemical energy is transformed into mechanical or electrical energy, or into osmotic work, as is the case in the work of muscles, nerves, and secretions.”

The energy for all these functions is supplied by ATP.

Professor Albert Szent-Györgyi



But the ATP participates also in the elaboration of DNA and RNA, and in the synthesis of Coenzyme A, anf these functions are also very crucial.


Lipides
Glucides
Protéines
Pyruvate
Acides gras
Aminoacides
Acétyl-CoA
Cycle de Krebs
CO_2
Acétyl-CoA
Malonyl-CoA
Acétoacétyl-CoA
Acétyl-CoA
Hydroxyméthyl
glutaryl-CoA
Acides gras
Corps cétoniques
Cholestérol
Prostaglandines
Acides biliaires
Triacyglycérols
et autres lipides
complexes
Hormones
stéroïdes

As we saw in the previous slide, acetyl-CoA is the point of convergence for all catabolisms: glycolysis, beta-oxidation of fatty acids, ketone bodies, and certain amino acids.

All the stages of the Krebs cycle, electron transport, and oxidative phosphorylation are common to all catabolisms and depend, **for energy production, on the presence of sufficient oxygen for the last two stages of tissue respiration (electron transport and oxidative phosphorylation).**

Due to the **extreme toxicity of oxygen in the form of free radicals** that can alter the chemical structures of fixed molecules, free substrates, and membranes, **respiration is the most tightly controlled functional mechanism**.

The key to respiration lies in maintaining the body's enzymatic and physicochemical capabilities and preserving the redox energy level that regulates the body's water fermentation.

Outside of its crucial regulatory framework, tissue respiratory balance is disrupted.

Tissues then shift from water fermentation under high redox potential to residual fermentation, a source of accumulating waste and acidosis, initially respiratory, then metabolic.

The benefit of this respiration materializes as energy that is transferred, stored, and used to carry out tissue synthesis, structural repair, or functional reactivation.

The biochemical reactions observed in an individual throughout their life are redox reactions, as they generally involve the exchange of hydrogen, oxygen, or other elements acting as oxidants or reducers.

Redox reactions in a living organism are ubiquitous and interdependent.

This helps to better understand the interdependence of systems and organs.

Redox reactions are representative of an individual's state at every moment.

Their sequence and regulation account for the organism's survival and adaptation.

In these redox reactions, electrons moving from one atom to another carry energy, and the electron's energy accompanies them during this transfer.

This explains the key role of redox reactions in the energy flow through living systems.

Multiple physiological, pathological, and pharmacological factors can influence their role.

Some drugs are electron donors, while others are electron acceptors (Cizmadia).

There are normal values for redox potential.

The redox potential decreases from the substrate to the electron and increases from the electron to oxygen.

It is necessarily regulated, and its regulator is entropy.

Oxygen is the respiratory determinant of the redox state.

From this, it is easy to understand the crucial importance of high-quality pulmonary ventilation to ensure optimal oxygen delivery to all tissues: energy production at maximum efficiency helps to control entropy and maintain redox reactions at their most efficient.

Indeed, just as tissue respiration allows for the gradual release and recovery of energy, the coupling of oxidation and reduction reactions is another "trick" that conserves energy by preventing its dissipation.

If the organism is able to mantain its energy (apart from the minimal loss due to interaction with the external environment), it functions harmoniously and coherently, and its entropy is minimal.

Under these conditions, life can last a long time.

Carnot's first principle is a principle of conservation of energy in a closed system. There can be no movement because there is neither gain nor loss of energy in a "closed system.

Energy balance here presupposes an internal equilibrium process within the organism and an external equilibrium process because there can be no exchange processes in a closed system.

Indeed, **biological systems obey Carnot's second principle, which governs** exchanges in an open system: there is consumption and dispersion of energy, and exchange of matter.

It is impossible to dissociate human life from its cosmic context, for reasons of thermodynamics, due to Carnot's second principle.

Energy varies, and this implies a concept of irreversibility between order and disorder, with the notion of entropy.

During every energy exchange, potential energy is dissipated as heat, which continually generates an increase in entropy.

This is how ordered but unstable systems spontaneously convert into less ordered but more stable systems.

"It is because, from a physicochemical standpoint, life is an open, and therefore unbalanced, system that life occurs. Everything happens as if a living organism, from conception to death, were merely a conduit for solar photonic energy transformed into chemical energy."

This transitional space maintains its structure for some time—that is, the relationships existing between the atoms and molecules that compose it—in a certain spatiotemporal orientation that can indeed give the impression of equilibrium." – **Henri Laborit**

The sun's energy is stored as potential energy in the covalent bonds between the atoms of molecules.

Entropy can be likened to an indirect measure of molecular disorder along the time axis. This disorder can only increase. We will discuss this further later.

AS we have een, biological phenomena and respiration obey Carnot's second law and are governed by the concept of entropy.

Thermodynamics is the science that studies the relationships governing the quantitative transformations of energy from one form to another during the physicochemical variations of a system.

The term "thermodynamics" is linked to the fact that all living phenomena result from a physiological reference temperature specific to the species.

The temperature at which an organism is maintained directly regulates the intensity of oxidation.

In humans, the temperature must be 36.8°C: in this case, entropy is low (5%), redox and tissue respiration are normal, and free radicals are stable.

If the temperature drops, entropy remains the same, but redox decreases slightly and free radicals increase.

If the temperature rises above 37.5°C, entropy expands, redox decreases, and free radicals increase. The increase in entropy consumes ATP. Therefore, there is a disruption of the respiratory chain and redox processes, as well as a release of free radicals.

How is life possible?

Conditions: physical, genetic, biological, biophysical, economic, social, etc.

Conformations: cultural, educational

Main mechanisms involved in the phenomenon of "Life":

- Tissue Respiration
- Energy Balance
- Constructive Time

1/ Tissue Respiration, a biological phenomenon without which Life would not exist. For this process to occur according to the laws and conditions of thermodynamics, it must be part of the development of devices and systems such as:

- Pulmonary ventilation
- Cardiovascular dynamic activation
- Blood oxygenation through gas transport under rigorous physicochemical constraints
- Substrate oxidation

https://www.youtube.com/watch?v=eJ9Zjc-jdys

Fermentation:

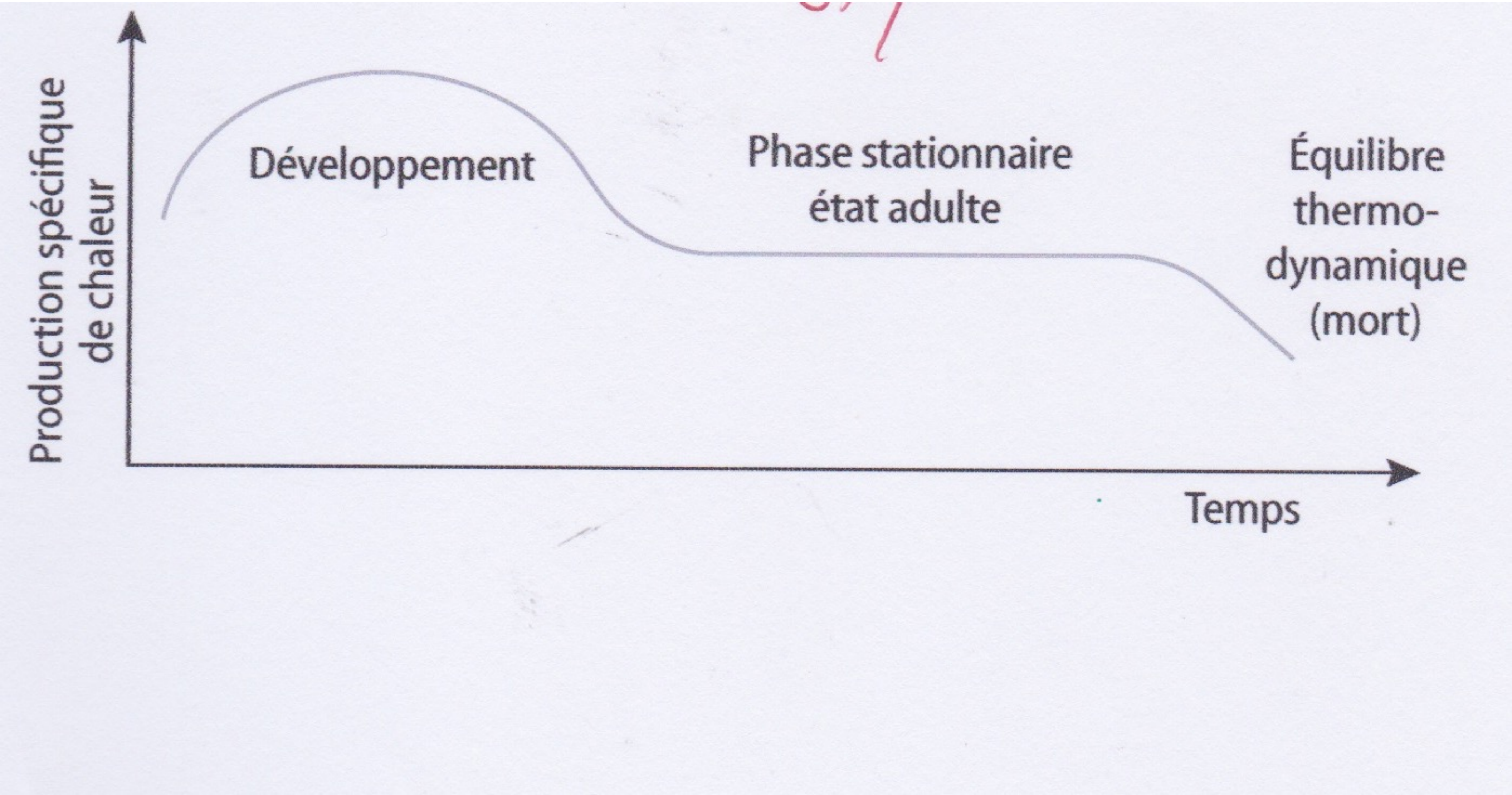
https://www.youtube.com/watch?v=YbdkbCU20_M

2/ Energy balance (see above)

3/ Constructive time.

Time is constructive only in biology: trees bloom and bud again each spring.

In humans, time is physically organized to allow the brain to develop, and it only reaches its maximum potential after puberty: for 12 to 15 years, physical development is framed, limited, and controlled so that the brain can develop the maximum number of neural connections and store information. **The thymus participates in managing and controlling the growth of the child's organism.**


Production spécifique de chaleur
Développement
Phase stationnaire
état adulte
Équilibre
thermo-
dynamique
(mort)
Temps

Physiology

According to the WHO: “Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”

This universally accepted definition is simply one manifestation of the state of health.

Health could be defined as a state of optimal tissue respiration (that is, at its most efficient) simultaneously in all the body's tissues and organs.

More precisely, health results from:

- functional and cellular normoxia

- balanced redox potential in all tissues

- functional central cholinergic function.

Mitochondrial tissue respiration is the fundamental process in all cells, resulting in energy production in the form of ATP.

ATP is the universal fuel used in all physiological processes.

Tissue respiration is both the starting point and the culmination of health.

Its disturbances are the starting point for functional disorders, which pave the way for pathologies.

Cellular respiration involves the participation of cellular metabolism, culminating in the release of 36 ATP molecules during water fermentation.

Tissue respiration involves the use of energy reserves, leading to energy enrichment.

To function optimally and in a coordinated manner, it is under strict and constant autonomic control.

A complete cell respiration cycles unfolds in **few milliseconds seconds only!**

Health, as well as its maintenance and preservation, depends on the quality and efficiency of this tissue respiration.

This control helps to minimize potential imbalances in respiration, which can occur:

- In cases of excess oxygen relative to hydrogen: this leads to the formation of free radicals, responsible for oxidation and aging. **(Reminder: oxidation is the loss of electrons)**

- Conversely, if there is less oxygen than necessary, there will be an accumulation of H^+ ions, initially resulting in respiratory acidosis, followed by tissue acidosis, along with their associated disorders.

These two deviations generate entropy and, if left unchecked, will lead to disorder (functional disturbances), disorganization (pathologies), and then chaos (generalized disorganization that can lead to death).

We can thus easily understand that in the event of a disruption of the functional balance between the sympathetic and parasympathetic systems, the efficiency of tissue respiration is reduced, and therefore, with less energy, a functional disorder can appear, accompanied by an increase in entropy **outside acceptable limits…**

In 1925, René Leriche wrote: *“The functional often precedes the anatomical, and it is the functional that creates it.*

Some of our most typical diseases, those we describe as entities, are merely the late outcome of a slow deviation in tissue physiology, under influences that are not specific to any cause. They are milestones, the outcome of a play whose first acts are performed before the candles are even lit. It is these actions in the night that provide the explanation for the plot.”

This tissue respiration involves numerous stages, each vulnerable due to the fragility and potential exhaustion of the cellular thermodynamic pole, with the possibility of partial or total blockage during an attack, whether physical, chemical, microbial, viral, etc.

The organism is not separated into small, independent functional entities, but is composed of a set of tissues, organs, and functions perfectly coordinated at every moment by the brain, which is constantly occupied day and night with coordinating the tissue respiration of all the body's organs and tissues.

This explains the absolute prioritization of its glucose and oxygen supply compared to other organs.

Even a local disruption of tissue respiration, due to trauma or an attack, for example, will have repercussions on the entire organism (and more specifically on certain organs).

This will (if the local disorder persists) provide some assistance to the dysfunctional or damaged tissue: a portion of the energy necessary for its optimal function will be "diverted" and used to try to compensate for the energy loss and disorder generated in the affected tissue(s), accompanied by an entropic rise.

The organism's priority then becomes controlling this entropic rise.

If it is not controlled, we will witness a progressive dysregulation of various functions and organs (or even the development of pathologies), which helps us understand the mechanisms of pathophysiological progression and the extent of the symptomatology.

Photonic medicine through its energy input respects, supports, regenerates, and allows for the recreation of normal physiology.

Physiology is the science of normal life.

It rests on two fundamental rules:

- a thermodynamic energetic rule,
- a vitalistic energetic rule, which is cellular respiration.

Biological life is simply the result of the synchronization of a multitude of mechanistic and physiological phenomena.

(Text of Laborit on physiology to read)

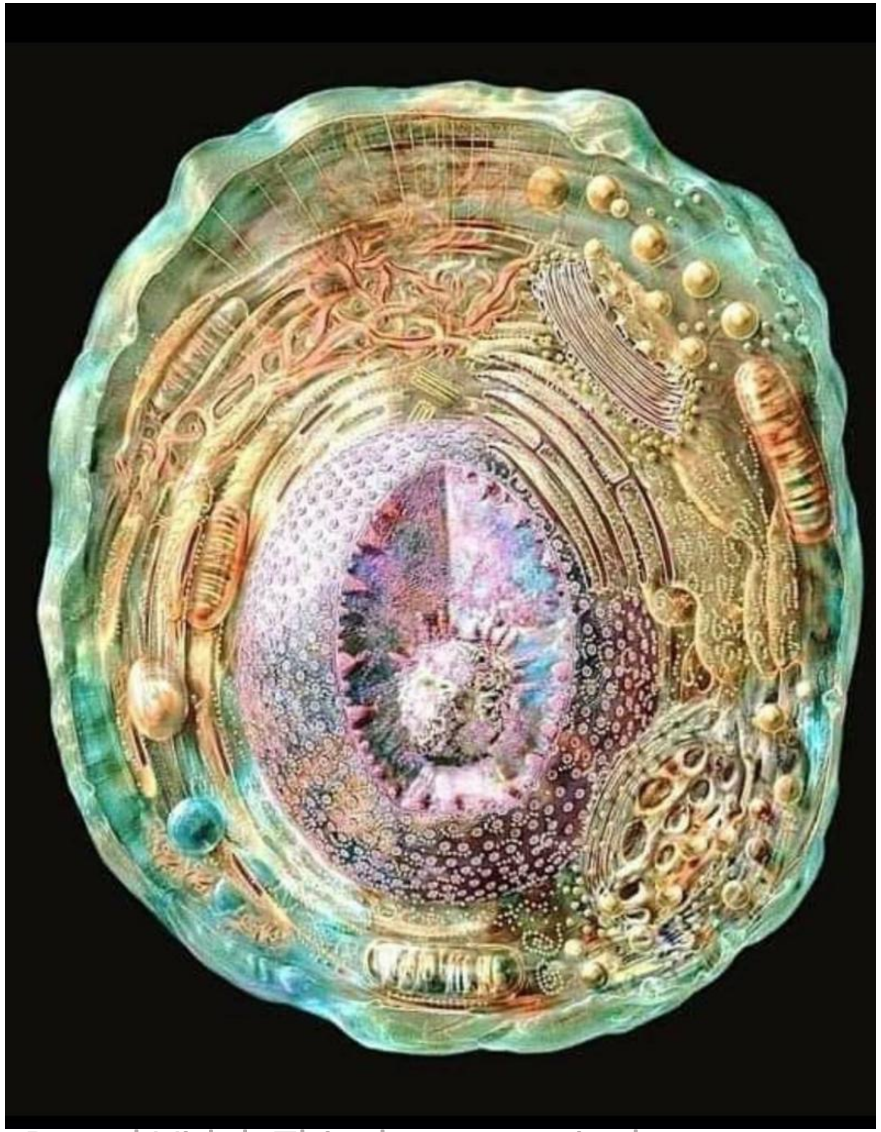
The central idea of physiology is the functional unity of respiration and the chronobiology of the system, which is modulating and harmonizing and cannot be separated.

All internal functions are under strict autonomic control.

(we will come back later on the body functions)

We are individuals in a state of perpetual vibration. All molecules vibrate at every moment; They are called upon to vibrate, cell by cell, nucleus by nucleus.

The cell is composed of its nucleus, cytoplasm, mitochondria, and other organelles.



We live in an electromagnetic environment, and our physical appearance is only a relative appearance, a small part of our physical reality.

This explains the resonance, at every location and at every moment, of the radiation we receive with the receptors in our body, such as cell nuclei, the oxygen transported by red blood cells (which is resonant oxygen), cell filaments, etc.

PATHOLOGY

If, as we have seen, health results from:

- functional and cellular normoxia

- balanced redox between all tissues

- functional central cholinergy…

… then pathology arises from:

1/ Tissue hypoxia

2/ Dysmetabolism

3/ Cholinergic deafferentation.

Every pathology begins as a disruption or break in cellular electromagnetic coupling: activations are blocked, and there is an energy loss, which will eventually make normal and harmonious functioning at 37°C impossible.

This rupture or blockage is like water seeping through a cracked tile on a house's roof: if it isn't repaired, the water seeps in continuously, rotting the beams and flooring, and irreversibly damaging the house.

Thank you for your kind attention