

A QUÍMICA EM NÚMEROS

QUAL O PRINCIPAL NÚMERO OU CONSTANTE EM QUÍMICA?

Número de Avogadro $N = 6,0221515 \times 10^{23}$

Constante de Boltzmann $k = 1,380649 \times 10^{-23}$ Joules/Kelvin

QUAL É A RELAÇÃO ENTRE ESTAS DUAS CONSTANTES?

$Nk = R = 8,314477$ J/mol K
(constante dos gases ideais)

118 Elementos Químicos (92 são naturais)

1) Qual é o número de compostos químicos conhecidos?

2) Qual é o número de compostos químicos catalogados (CAS number)?

3) Qual é o número de compostos químicos que podem existir?

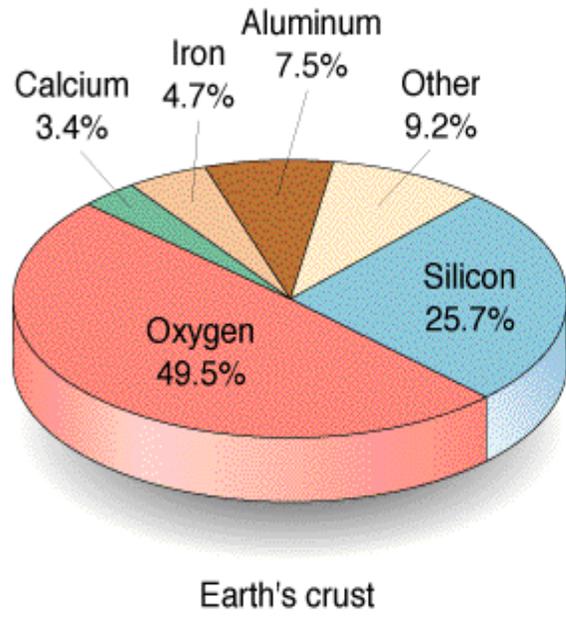
100 milhões = 10^8

400 mil = 4×10^5

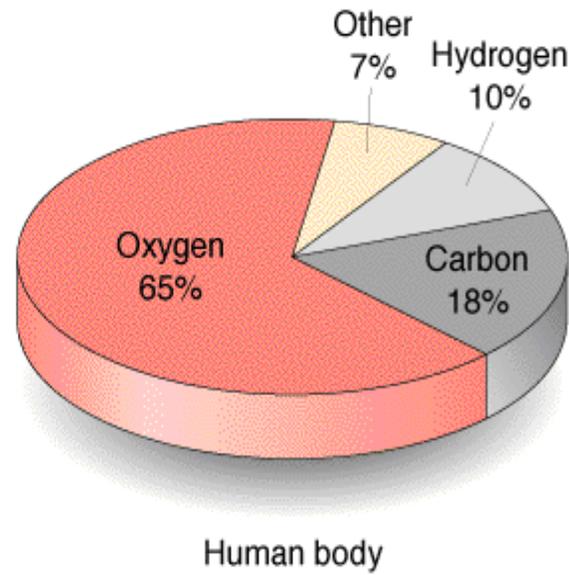
10^{60}

Espaço Químico

Composições Atômicas Aproximadas da Crosta Terrestre e do Corpo Humano

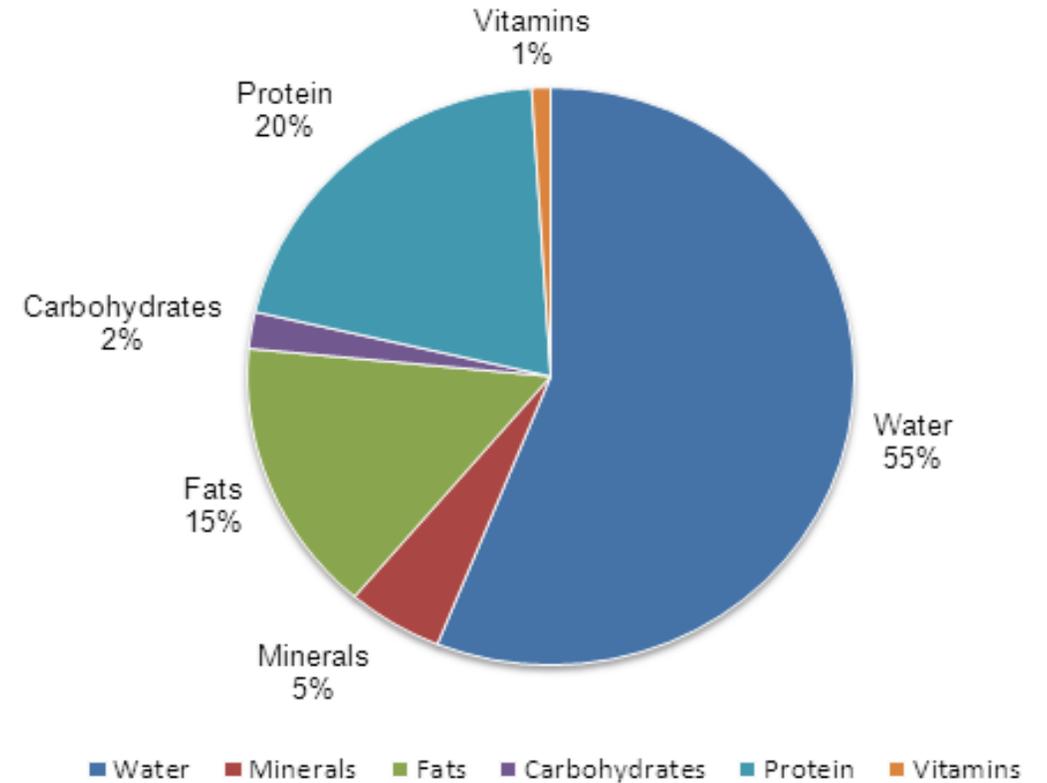


(a)



(b)

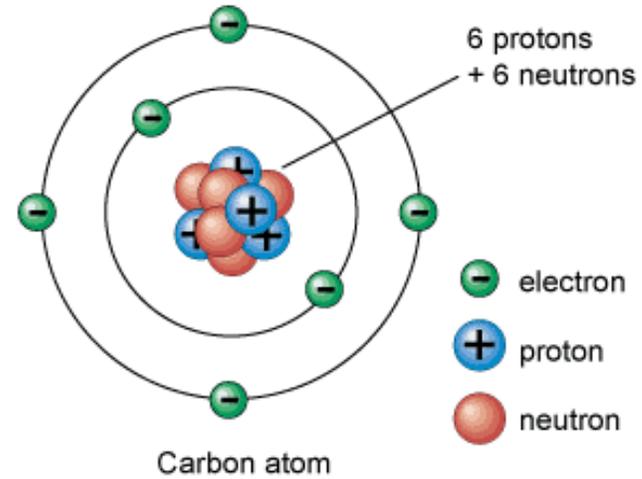
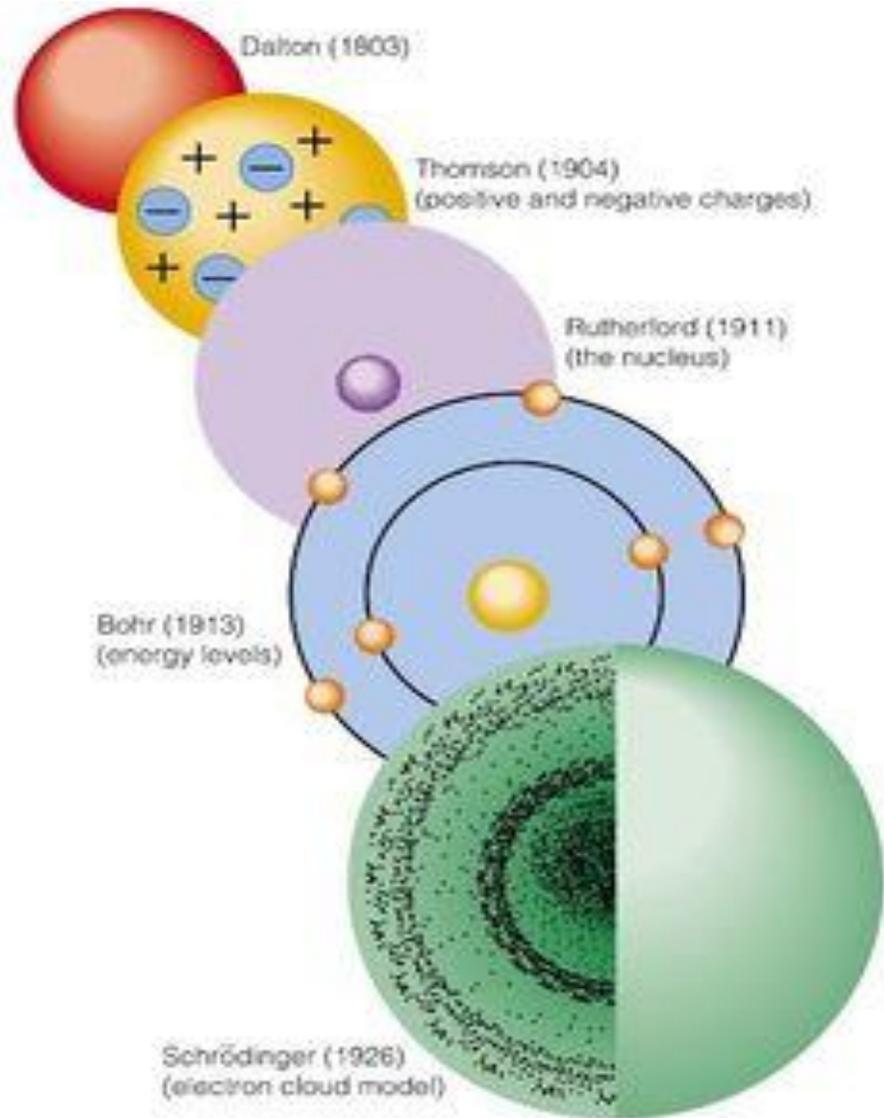
Composition of the Body



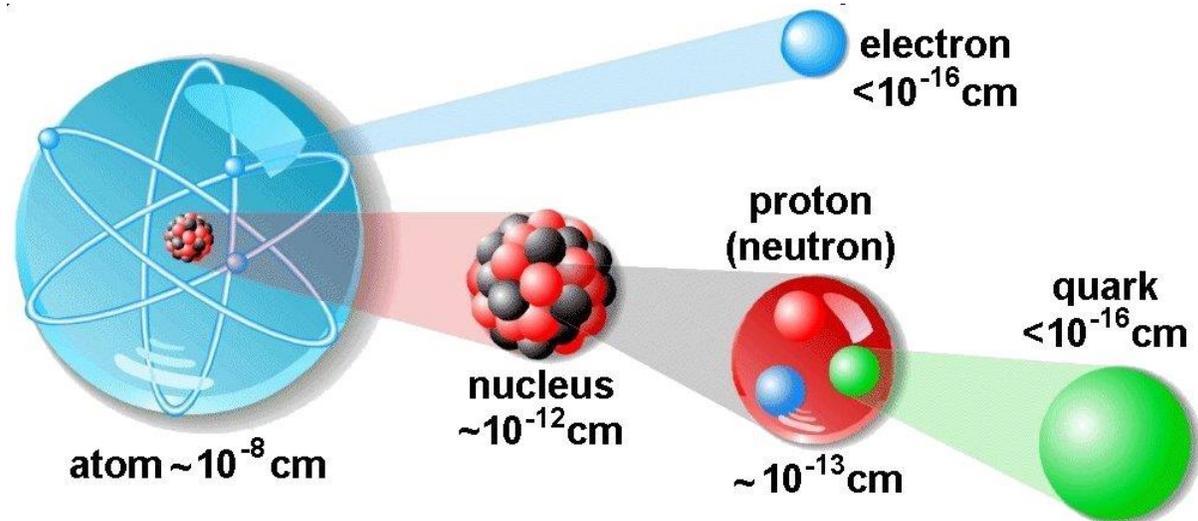
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																														
1 H HIDROGÊNIO 1.00794	TABELA PERIÓDICA () = ESTIMATIVA																2 He HÉLIO 4.002602																														
3 Li LÍTIO 6.941 4 Be BERILIO 9.012182 11 Na SÓDIO 22.989770 12 Mg MAGNÉSIO 24.3050		FAMÍLIA 1 Metal Alcalino 17 Halogênios 2 Metal Alcalino Terroso 18 Gases Nobres 3 a 12 Metal de Transição										5 B BORO 10.811 6 C CARBONO 12.0107 7 N NITROGÊNIO 14.0067 8 O OXIGÊNIO 15.9994 9 F FLUOR 18.9984032 10 Ne NEÔNIO 20.1797 13 Al ALUMÍNIO 26.981538 14 Si SILÍCIO 28.0855 15 P FÓSFORO 30.973761 16 S ENXOFRE 32.065 17 Cl CLORO 35.453 18 Ar ARGÔNIO 39.948																																			
19 K POTÁSSIO 39.0983	20 Ca CÁLCIO 40.078	21 Sc ESCÂNDIO 44.955910	22 Ti TITÂNIO 47.867	23 V VANÁDIO 50.9415	24 Cr CROMO 51.9961	25 Mn MANGANÊS 54.938049	26 Fe FERRO 55.845	27 Co COBALTO 58.933200	28 Ni NÍQUEL 58.6934	29 Cu COBRE 63.546	30 Zn ZINCO 65.409	31 Ga GÁLIO 69.723	32 Ge GERMÂNIO 72.64	33 As ARSÊNIO 74.92160	34 Se SELÊNIO 78.96	35 Br BROMO 79.904	36 Kr CRÍPTONO 83.798																														
37 Rb RUBÍDIO 85.4678	38 Sr ESTRÔNCIO 87.62	39 Y ÍTRIO 88.90585	40 Zr ZIRCONÍO 91.224	41 Nb NÍOBIO 92.90638	42 Mo MOLIBDÊNIO 95.94	43 Tc TECNÉCIO 97.9072	44 Ru RUTÊNIO 101.07	45 Rh RÓDIO 102.90550	46 Pd PALÁDIO 106.42	47 Ag PRATA 107.8682	48 Cd CADMIO 112.411	49 In ÍNDIO 114.818	50 Sn ESTANHO 118.710	51 Sb ANTIMÔNIO 121.760	52 Te TELÚRIO 127.60	53 I IODO 126.90447	54 Xe XENÔNIO 131.293																														
55 Cs CÉSIO 132.90545	56 Ba BÁRIO 137.327	<i>Lantanídeos</i>		72 Hf HÁFNIO 178.49	73 Ta TANTÁLIO 180.9479	74 W TUNGSTÊNIO 183.84	75 Re RÊNIO 186.207	76 Os ÓSMIO 190.23	77 Ir ÍRÍDIO 192.217	78 Pt PLATINA 195.078	79 Au OURO 196.96655	80 Hg MERCÚRIO 200.59	81 Tl TÁLIO 204.3833	82 Pb CHUMBO 207.2	83 Bi BISMUTO 208.98038	84 Po POLÔNIO 208.9824	85 At ASTATO 209.9871	86 Rn RADÔNIO 222.0176																													
87 Fr FRÂNCIO 223.0197	88 Ra RÁDIO 226.0254	<i>Actinídeos</i>		104 Rf RUTHERFÓDIO 261.1088	105 Db DÚBNIÓ 262.1141	106 Sg SEABÓRGIO 266.1219	107 Bh BÓHRIO 264.12	108 Hs HÁSSÍO (277)	109 Mt MEITENÉRIO 268.1388	110 Ds DARMSTADTÍO (271)	111 Rg ROENTGÊNIO (272)																																				
<table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td>57 La LANTÂNIO 138.9055</td> <td>58 Ce CÉRIO 140.116</td> <td>59 Pr PRASEODÍMIO 140.90765</td> <td>60 Nd NÉODÍMIO 144.24</td> <td>61 Pm PROMÉCIO 144.9127</td> <td>62 Sm SAMÁRIO 150.36</td> <td>63 Eu EURÓPIO 151.964</td> <td>64 Gd GADOLÍNIO 157.25</td> <td>65 Tb TÉRBIO 158.92534</td> <td>66 Dy DISPRÓDIO 162.500</td> <td>67 Ho HÓLMIO 164.93032</td> <td>68 Er ÉRBITO 167.259</td> <td>69 Tm TULÍO 168.93421</td> <td>70 Yb ÍTERBIO 173.04</td> <td>71 Lu LUTÉCIO 174.967</td> </tr> <tr> <td>89 Ac ACTÍNIO 227.0277</td> <td>90 Th TÓRIO 232.0381</td> <td>91 Pa PROTACTÍNIO 231.03588</td> <td>92 U URÂNIO 238.02891</td> <td>93 Np NEPTÚNIO 237.0482</td> <td>94 Pu PLUTÔNIO 244.0642</td> <td>95 Am AMÉRICIO 243.0614</td> <td>96 Cm CÚRIO 247.0704</td> <td>97 Bk BERQUÍLIO 247.0703</td> <td>98 Cf CALIFÓRNIO 251.0796</td> <td>99 Es ENSTEÍNIO 252.0830</td> <td>100 Fm FERMÍO 257.0951</td> <td>101 Md MENDELÉVIO 258.0984</td> <td>102 No NOBÉLIO 259.1010</td> <td>103 Lr LAURÊNCIO 262.1097</td> </tr> </tbody> </table>																		57 La LANTÂNIO 138.9055	58 Ce CÉRIO 140.116	59 Pr PRASEODÍMIO 140.90765	60 Nd NÉODÍMIO 144.24	61 Pm PROMÉCIO 144.9127	62 Sm SAMÁRIO 150.36	63 Eu EURÓPIO 151.964	64 Gd GADOLÍNIO 157.25	65 Tb TÉRBIO 158.92534	66 Dy DISPRÓDIO 162.500	67 Ho HÓLMIO 164.93032	68 Er ÉRBITO 167.259	69 Tm TULÍO 168.93421	70 Yb ÍTERBIO 173.04	71 Lu LUTÉCIO 174.967	89 Ac ACTÍNIO 227.0277	90 Th TÓRIO 232.0381	91 Pa PROTACTÍNIO 231.03588	92 U URÂNIO 238.02891	93 Np NEPTÚNIO 237.0482	94 Pu PLUTÔNIO 244.0642	95 Am AMÉRICIO 243.0614	96 Cm CÚRIO 247.0704	97 Bk BERQUÍLIO 247.0703	98 Cf CALIFÓRNIO 251.0796	99 Es ENSTEÍNIO 252.0830	100 Fm FERMÍO 257.0951	101 Md MENDELÉVIO 258.0984	102 No NOBÉLIO 259.1010	103 Lr LAURÊNCIO 262.1097
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Modelos Atômicos

ESTRUTURA DA MATÉRIA ÁTOMOS, MOLÉCULAS E ÍONS



DIMENSÕES



Standard Model of FUNDAMENTAL PARTICLES AND INTERACTIONS

The Standard Model summarizes the current knowledge in Particle Physics. It is the quantum theory that includes the theory of strong interactions (quantum chromodynamics or QCD) and the unified theory of weak and electromagnetic interactions (electroweak). Gravity is included on this chart because it is one of the fundamental interactions even though not part of the "Standard Model."

FERMIONS

matter constituents
spin = 1/2, 3/2, 5/2, ...

Leptons spin = 1/2			Quarks spin = 1/2		
Flavor	Mass GeV/c ²	Electric charge	Flavor	Approx. Mass GeV/c ²	Electric charge
ν_e electron neutrino	$<1 \times 10^{-8}$	0	u up	0.003	2/3
e electron	0.000511	-1	d down	0.006	-1/3
ν_μ muon neutrino	<0.0002	0	c charm	1.3	2/3
μ muon	0.106	-1	s strange	0.1	-1/3
ν_τ tau neutrino	<0.02	0	t top	175	2/3
τ tau	1.7771	-1	b bottom	4.3	-1/3

Spin is the intrinsic angular momentum of particles. Spin is given in units of \hbar , which is the quantum unit of angular momentum, where $\hbar = h/2\pi = 6.58 \times 10^{-25}$ GeV s = 1.05×10^{-34} J s.

Electric charges are given in units of the proton's charge. In SI units the electric charge of the proton is 1.60×10^{-19} coulombs.

The **energy** unit of particle physics is the electronvolt (eV), the energy gained by one electron in crossing a potential difference of one volt. **Masses** are given in GeV/c² (remember $E = mc^2$), where 1 GeV = 10^9 eV = 1.60×10^{-10} joule. The mass of the proton is 0.938 GeV/c² = 1.67×10^{-27} kg.

BOSONS

force carriers
spin = 0, 1, 2, ...

Unified Electroweak spin = 1			Strong (color) spin = 1		
Name	Mass GeV/c ²	Electric charge	Name	Mass GeV/c ²	Electric charge
γ photon	0	0	g gluon	0	0
W⁻	80.4	-1			
W⁺	80.4	+1			
Z⁰	91.187	0			

Color Charge

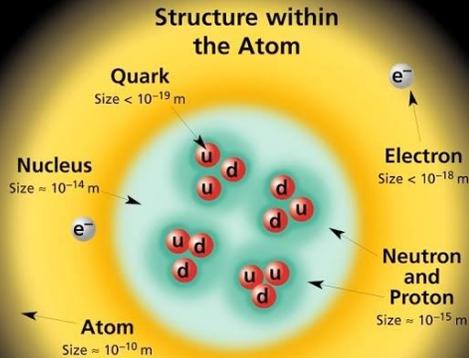
Each quark carries one of three types of "strong charge," also called "color charge." These charges have nothing to do with the colors of visible light. There are eight possible types of color charge for gluons. Just as electrically-charged particles interact by exchanging photons, in strong interactions color-charged particles interact by exchanging gluons. Leptons, photons, and **W** and **Z** bosons have no strong interactions and hence no color charge.

Quarks Confined in Mesons and Baryons

One cannot isolate quarks and gluons; they are confined in color-neutral particles called **hadrons**. This confinement (binding) results from multiple exchanges of gluons among the color-charged constituents. As color-charged particles (quarks and gluons) move apart, the energy in the color-force field between them increases. This energy eventually is converted into additional quark-antiquark pairs (see figure below). The quarks and antiquarks then combine into hadrons; these are the particles seen to emerge. Two types of hadrons have been observed in nature: **mesons** $q\bar{q}$ and **baryons** qqq .

Residual Strong Interaction

The strong binding of color-neutral protons and neutrons to form nuclei is due to residual strong interactions between their color-charged constituents. It is similar to the residual electrical interaction that binds electrically neutral atoms to form molecules. It can also be viewed as the exchange of mesons between the hadrons.



If the protons and neutrons in this picture were 10 cm across, then the quarks and electrons would be less than 0.1 mm in size and the entire atom would be about 10 km across.

PROPERTIES OF THE INTERACTIONS

Baryons qqq and Antibaryons $\bar{q}\bar{q}\bar{q}$					
Baryons are fermionic hadrons. There are about 120 types of baryons.					
Symbol	Name	Quark content	Electric charge	Mass GeV/c ²	Spin
p	proton	uud	1	0.938	1/2
\bar{p}	anti-proton	$\bar{u}\bar{u}\bar{d}$	-1	0.938	1/2
n	neutron	udd	0	0.940	1/2
Λ	lambda	uds	0	1.116	1/2
Ω^-	omega	sss	-1	1.672	3/2

Property	Interaction	Gravitational	Weak (Electroweak)	Electromagnetic	Strong	
		Mass - Energy	Flavor	Electric Charge	Fundamental	Residual
Acts on:		Mass - Energy	Flavor	Electric Charge	Color Charge	See Residual Strong Interaction Note
Particles experiencing:		All	Quarks, Leptons	Electrically charged	Quarks, Gluons	Hadrons
Particles mediating:		Graviton (not yet observed)	W⁺ W⁻ Z⁰	γ	Gluons	Mesons
Strength relative to electromag for two u quarks at:		10^{-41}	0.8	1	25	Not applicable to quarks
		10^{-41}	10^{-4}	1	60	
for two protons in nucleus		10^{-36}	10^{-7}	1	Not applicable to hadrons	20

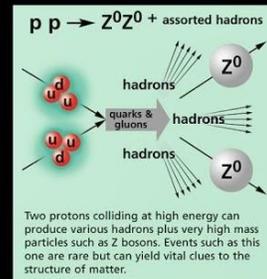
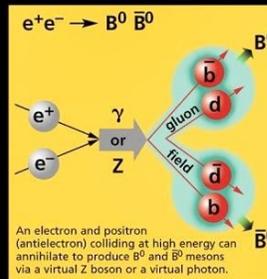
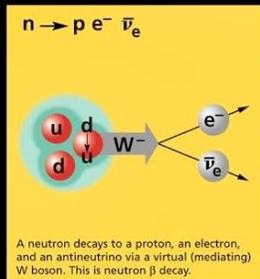
Mesons $q\bar{q}$					
Mesons are bosonic hadrons. There are about 140 types of mesons.					
Symbol	Name	Quark content	Electric charge	Mass GeV/c ²	Spin
π^+	pion	$u\bar{d}$	+1	0.140	0
K^-	kaon	$s\bar{u}$	-1	0.494	0
ρ^+	rho	$u\bar{d}$	+1	0.770	1
B^0	B-zero	$d\bar{b}$	0	5.279	0
η_c	eta-c	$c\bar{c}$	0	2.980	0

Matter and Antimatter

For every particle type there is a corresponding antiparticle type, denoted by a bar over the particle symbol (unless + or - charge is shown). Particle and antiparticle have identical mass and spin but opposite charges. Some electrically neutral bosons (e.g., Z^0 , γ , and $\eta_c = c\bar{c}$, but not $K^0 = d\bar{s}$) are their own antiparticles.

Figures

These diagrams are an artist's conception of physical processes. They are **not** exact and have **no** meaningful scale. Green shaded areas represent the cloud of gluons or the gluon field, and red lines the quark paths.



The Particle Adventure

Visit the award-winning web feature *The Particle Adventure* at <http://ParticleAdventure.org>

This chart has been made possible by the generous support of:

U.S. Department of Energy
U.S. National Science Foundation
Lawrence Berkeley National Laboratory
Stanford Linear Accelerator Center
American Physical Society, Division of Particles and Fields
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<http://CPEPweb.org>

Número de Avogadro $N = 6,0221515 \times 10^{23}$ é um número grande?

Um mol de água tem 18 g e mede 18 mL

Existe aproximadamente 10^{46} moléculas de H_2O somando todos os oceanos!!!

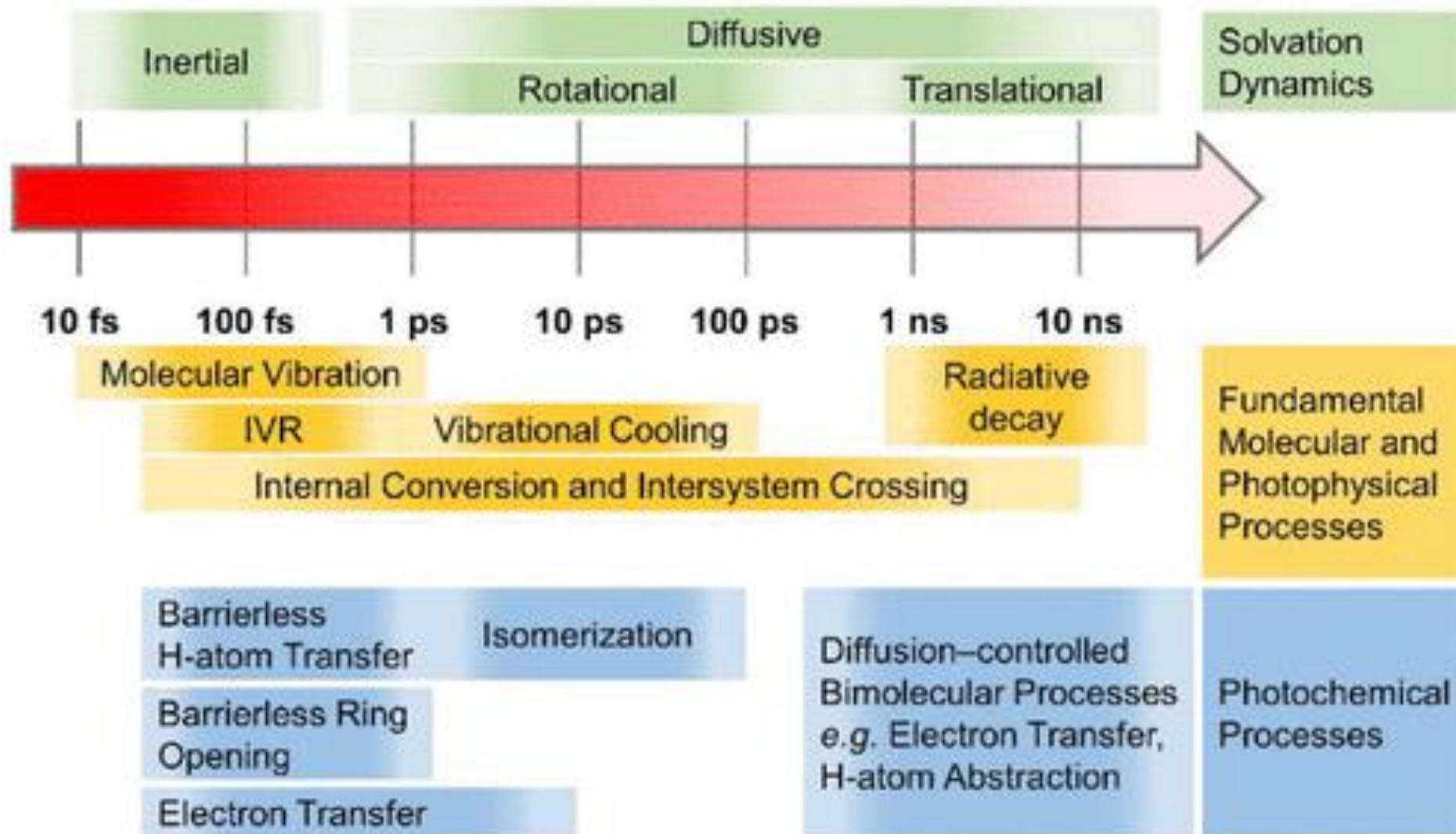
Número total de estrelas no Universo 10^{23}
Similar ao Número total de grãos de areia em
todas as praias

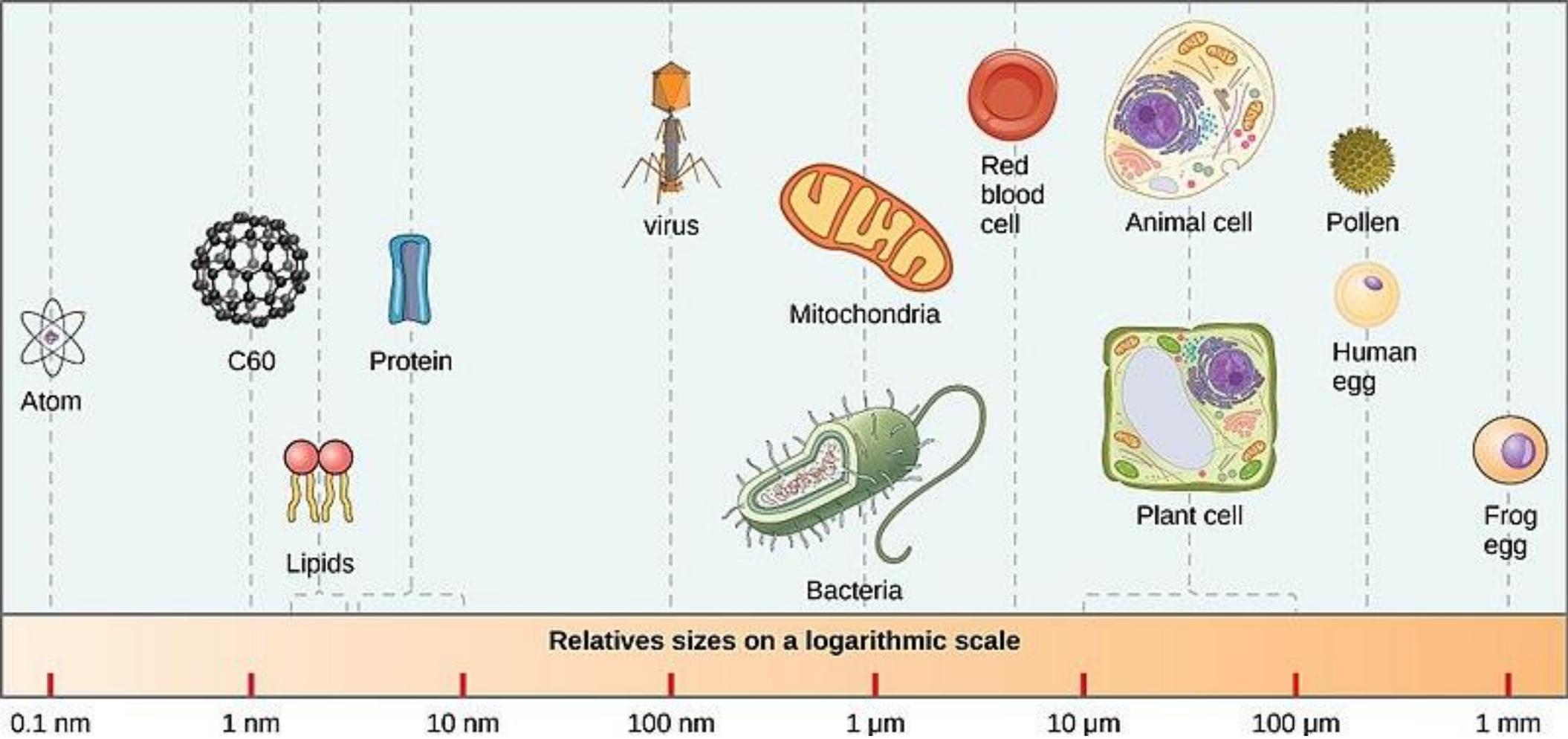


Uma pessoa tem aproximadamente
100 mil fios de cabelo, considerando a
população mundial de 8 bilhões temos
no total 10^{15} fios de cabelo



ESCALA TEMPORAL DE PROCESSOS MOLECULARES



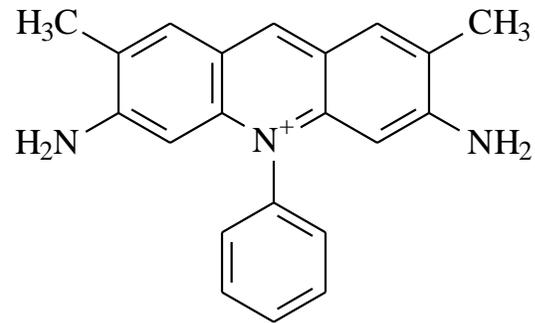
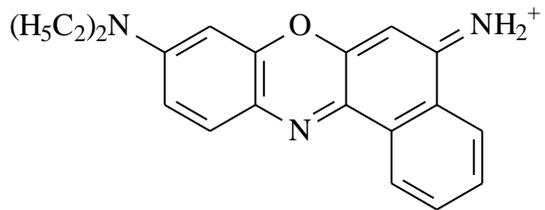


MICROSCOPIA ÓTICA

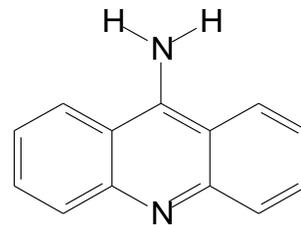
MICROSCOPIA ELETRÔNICA (FEIXE DE ELÉTRONS)

Corantes Orgânicos Moleculares

Azul do Nilo

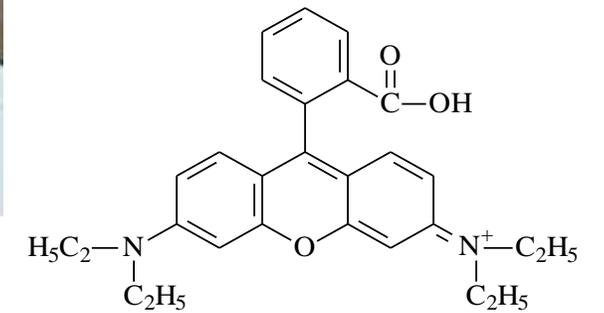
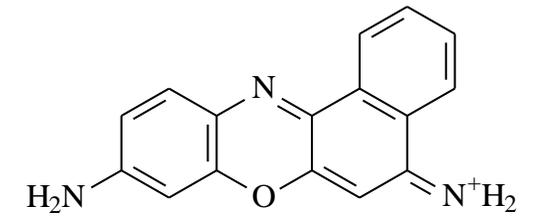


Safranina



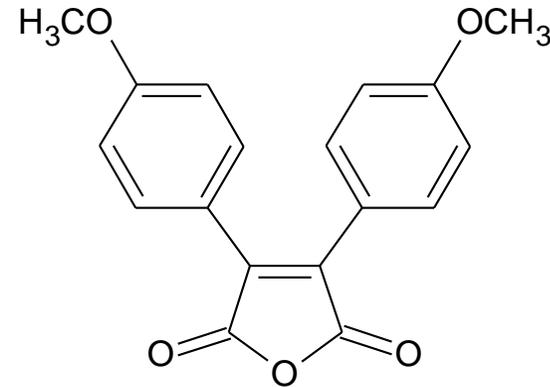
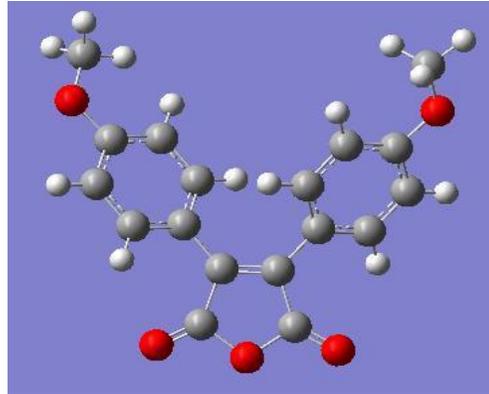
9-amino acridina

Violeta de cresila

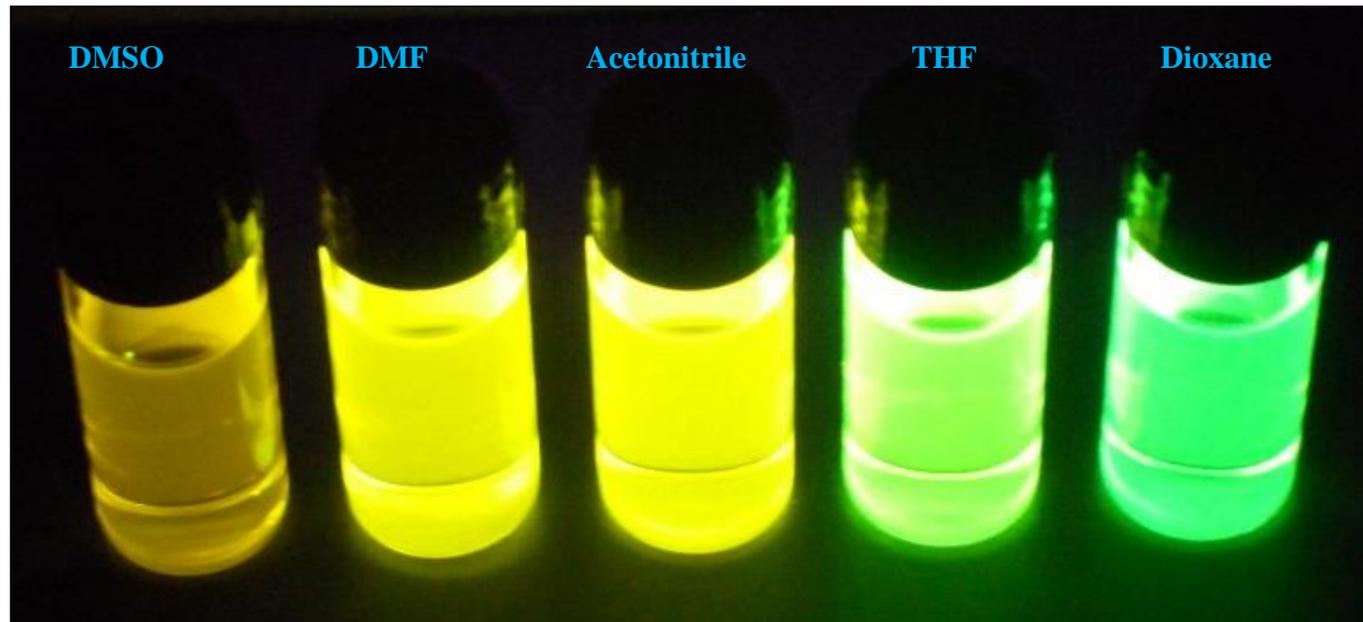


Rodamina B

COMO PODEMOS ALTERAR AS CARACTERÍSTICAS (ALGUMAS) DE UM COMPOSTO MOLECULAR ???



DERIVADO DE ANIDRIDO MALÉICO



COMO PODEMOS OBTER O MESMO COMPOSTO COM CARACTERÍSTICAS E PROPRIEDADES DIFERENTES ??



Efeito
Quântico de
tamanho

Nanopartículas de CdSe

