The Chemistry and Molecules of Life

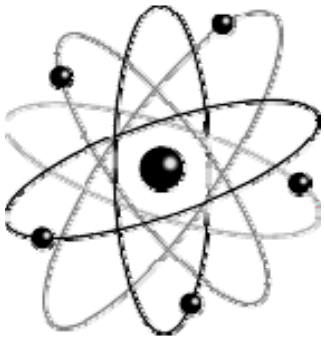
Cells are made of molecules & molecules are made of matter

MATTER... occupies space and has mass (weight)

made of **ELEMENTS**.... which are composed of ATOMS

NUCLEUS... **PROTONS** & **NEUTRONS**

ELECTRON... ORBITAL CLOUD... Orbital Stability



ATOMIC NUMBER = # protons present

ATOMIC MASS = # of protons + # of neutrons

also called atomic weight

compares atom to atom

units are called **Daltons** or amu

1 amu = 1/12th mass of carbon 1.0073

ION - electrically charged atom

loss of e^- = **OXIDATION**

gain of e^- = **REDUCTION**

ISOTOPE - atom with same # protons, but more neutrons

99% < carbon-12 $^{12}C_6$

1% < carbon-13 $^{13}C_6$

1% < carbon-14 $^{14}C_6$ half-life C - 5,730y

unstable = radioactivity n ---> p + e- $_6?^{14}$

^{14}C Dating - also called RADIOCARBON DATING

is a method of age determination that depends upon the decay of radiocarbon (carbon-14) to nitrogen .

^{14}Carbon- is continually formed in nature and is absorbed by plants and then passed on to animals through the food chain.

Radiocarbon spontaneously decays slowly in a living organism and the amount lost is continually replenished as long as the organism takes in air or food. Once the organism dies, however, it ceases to absorb ^{14}C, so that the amount of the radiocarbon present in its tissues at death steadily decreases.

^{14}C has a half-life of 5,730 +/- 40 years--

i.e., half the amount of the radioisotope present at any given time will undergo spontaneous disintegration during the succeeding 5,730 years.

a half-life is the time it takes for one-half of the parent isotope to decay to its daughter isotope (^{14}C to ^{14}N).

Because ^{14}C decays at this constant rate, an estimate of the date at which an organism died can be made by measuring the amount of its residual radiocarbon present now.

MOLECULE... a group of like or dissimilar atoms held together by a **CHEMICAL BOND** (an electrostatic attraction).

TYPES of BONDS: (energies 0 to > 1,000 cal/mol)

COVALENT - sharing of electrons between atomic nuclei
C-C and H-H

NON-COVALENT - electrostatic interactions (10-150 cal/mol)

1. **IONIC Bonds** - small ion attractions by charge [+/-]
   (CATION s/ ANIONs)... $_{11}$ **Na** $^{(2,8,1)}$ **&** $_{17}$ **Cl** $^{(2,8,7)}$
2. **DIPOLES** - attractions via asymmetrical internal distribution of charge without a net charge
   - Ionic Charge - DIPOLE -
   - DIPOLE - DIPOLE
   - Induced DIPOLE - Charge
   - Induced DIPOLE - DIPOLE
3. **DISPERSION** (van der Waal) **FORCES** - attraction based upon closeness of atomic nuclei
4. **HYDROGEN BOND** - electrostatic attraction between hydrogen of one atom & pair of non-bonded e's on an acceptor group electrostatically attract...

Individual non-covalent forces very weak, but billions can…
- hold two atoms together very tightly,
- forge a 3-D shape , that holds specific biological activity

CHEMICAL ARCHITECTURE of CELLS

WATER – Biological Role of Water

70% of mass of a cell is water (H2O)

role of water … solvent/product of reactions

$6CO_2 + 6H_2O$ <---> $C_6H_12O_6 + 6O_2$

its location in cells … is the soluble phase of the cell

bulk vs. **vicinal** (structural water ?)

Physical Properties water...exists in 3 forms

gas ⟵ liquid ⟶ solid

high : surface tension..... cohesiveness

specific heat..... heat 1 gm 1C

heat of vaporization..... 540 cal/gm

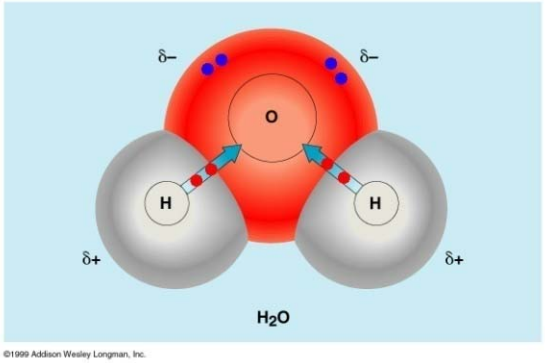
heat of fusion..... 79 cal/gm

density on freezing..... less dense

STRUCTURE of WATER...

a tetrahedral shape with unequal distribution of charge

i.e., it's a molecular dipole (magnet-like) +/-



Primary force – is its weak electrostatic interactions…

HYDROGEN BOND... not a "bond" at all