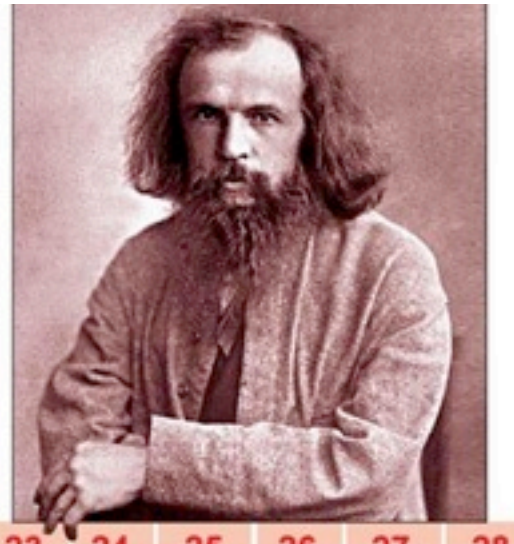
The Elements of Life

I. Review of Atomic Structure

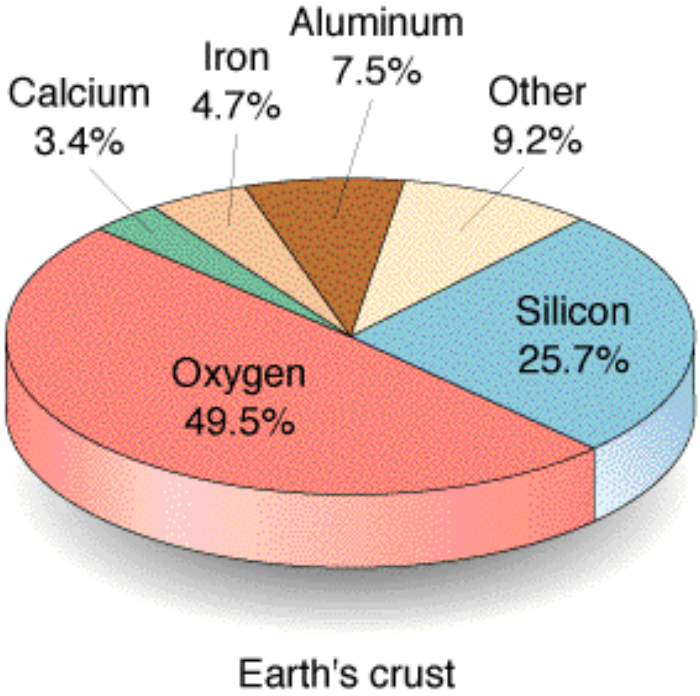
A. Elements
B. Atoms
C. Ions
D. Compounds

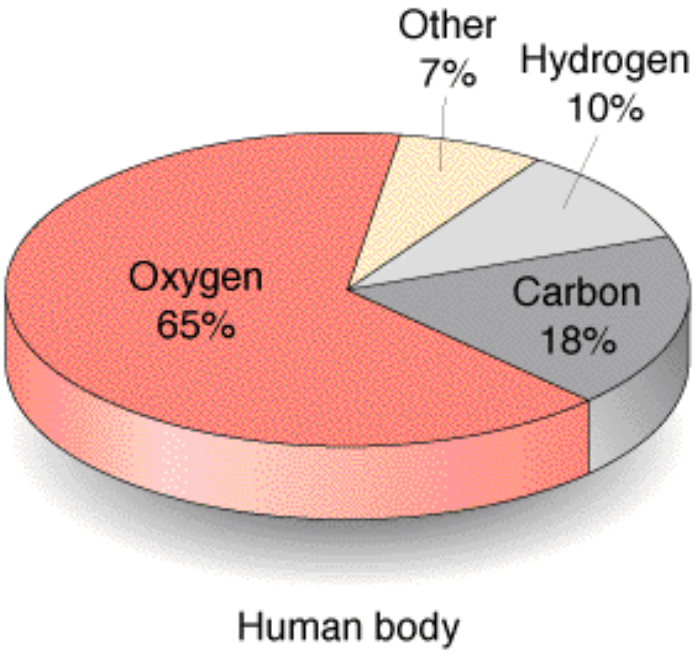
A. Elements-



1 H																2 He
3 Li	4 Be										5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Uuu	112 Uub	113 Uut	114 Uuq	115 Uup	116 Uuh		

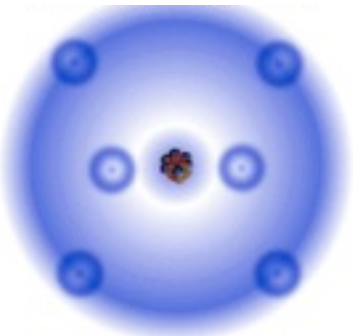
57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No





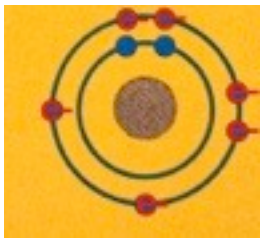
1. The 3 Most Common Elements in Living Things

Carbon- C



Hydrogen- H

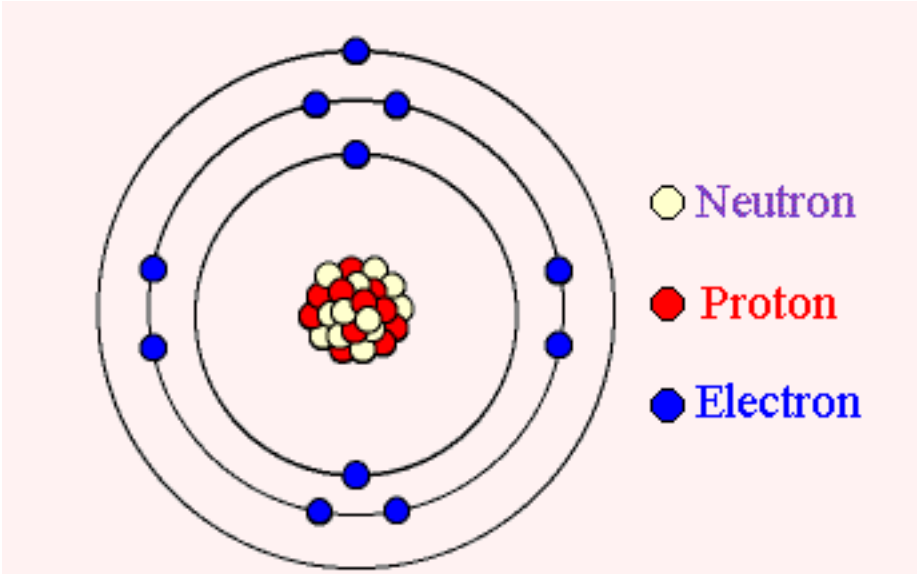
Oxygen- O



2. Other important elements
    a. N-
    b. P-
    c. Ca-
    d. Fe-
    e. Na-
    f. S-

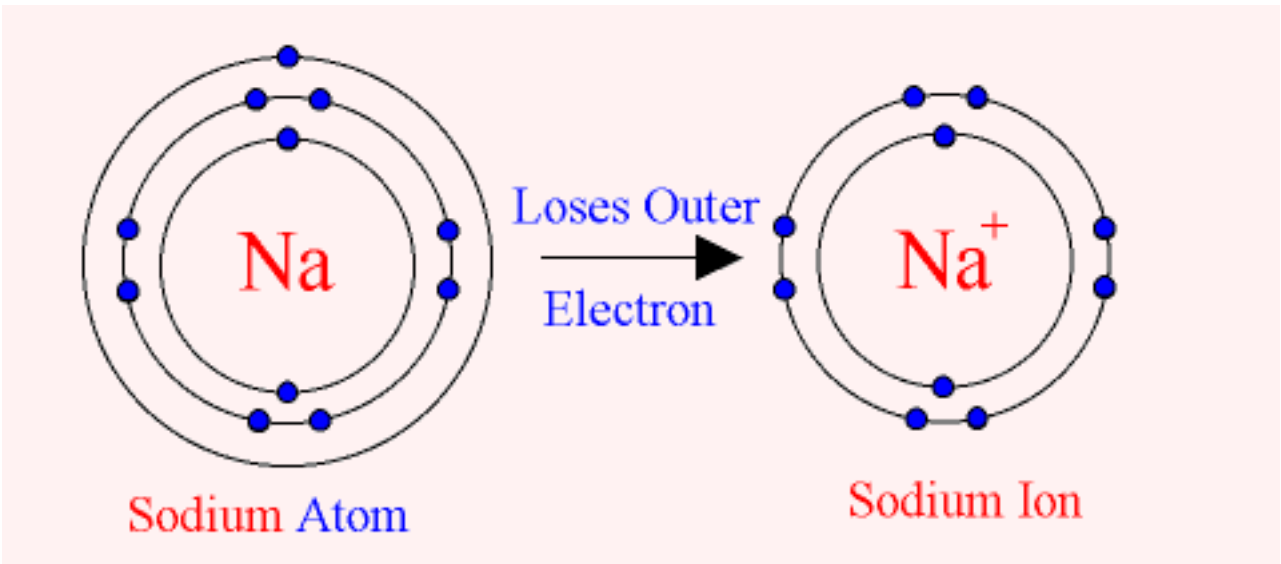
B. Atoms-

Subatomic Particle	Location in Atom	Charge	Mass



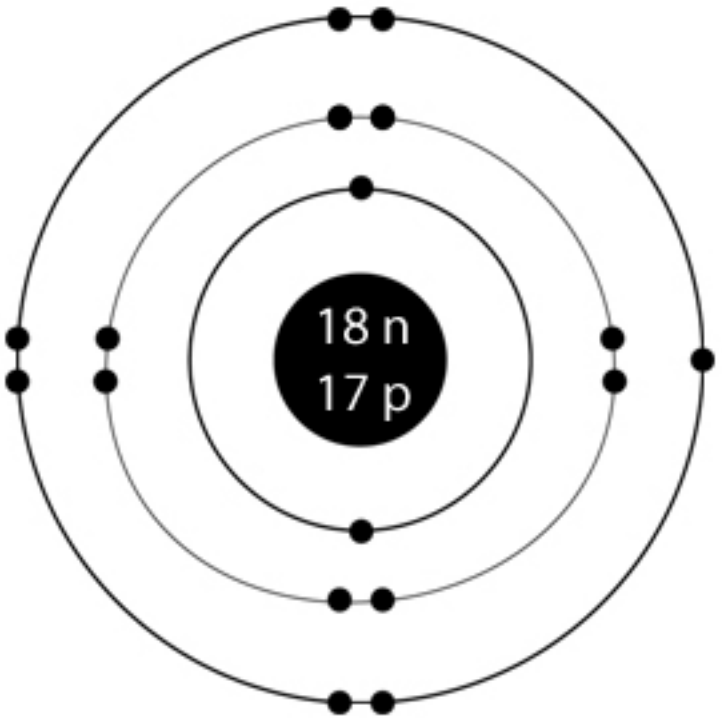
C. Ions-

Ex. Sodium
atomic number = 11



Ex. Chlorine

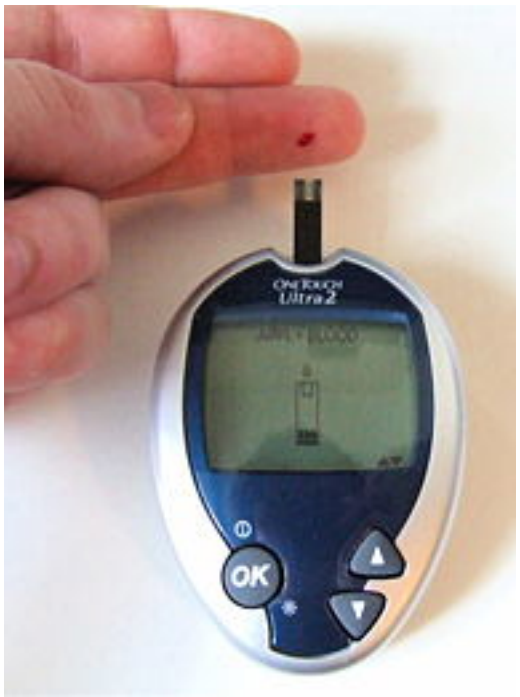
atomic number = 17

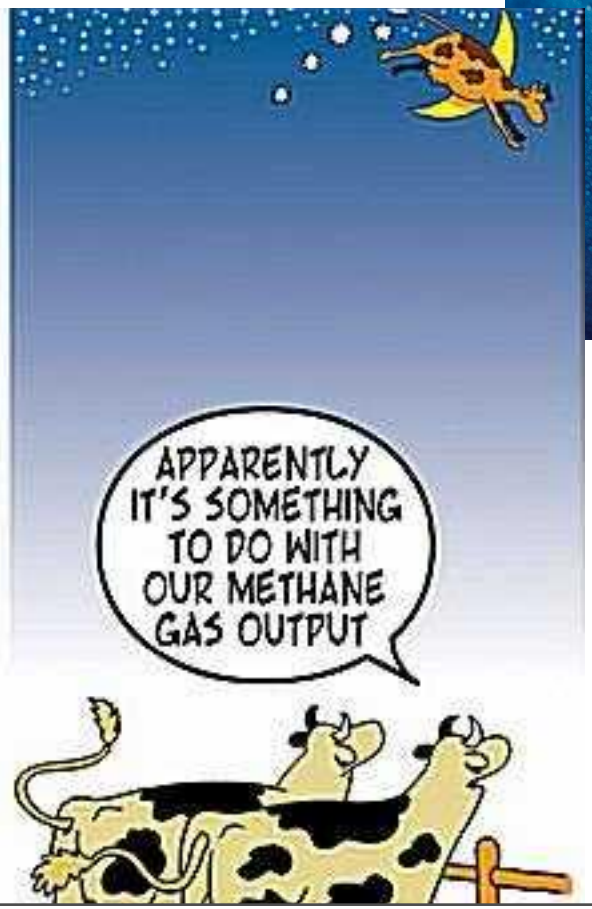


D. Compounds-

Exs.

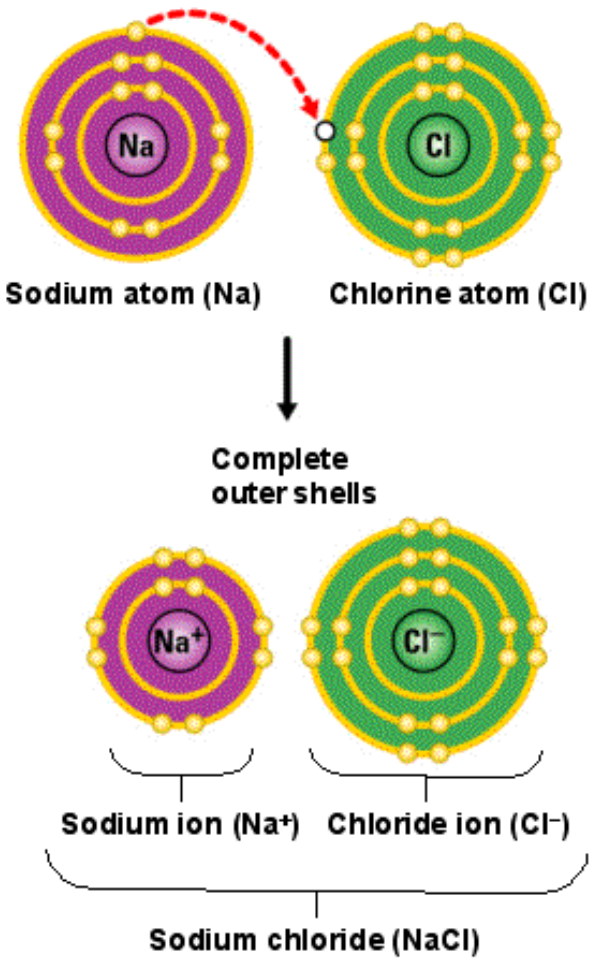
Salt	NaCl
Water	H_20
Ammonia	NH_3
Methane	CH_4
Glucose	$C_6H_{12}O_6$





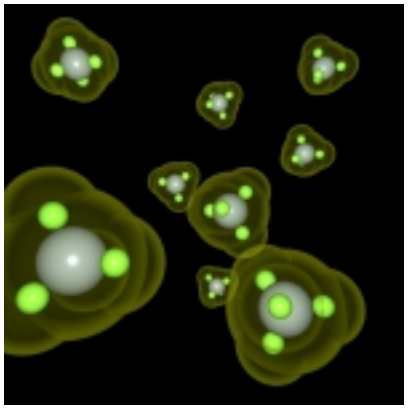
II. Types of Bonds

A. Ionic-



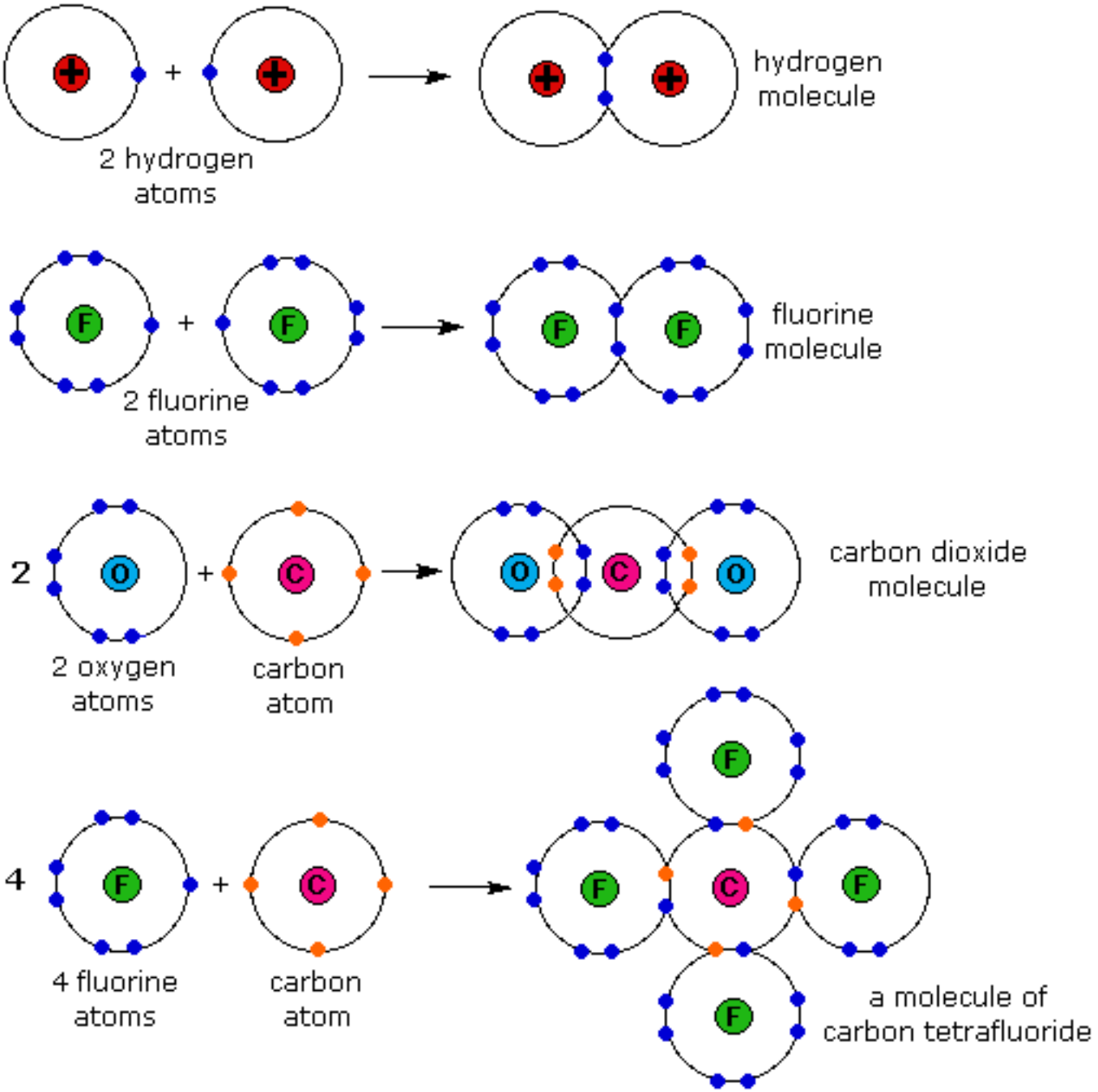
B. Covalent-

Ex. Methane- CH_4



a gas at
room temperature

capturing methane
from a landfill


+
hydrogen molecule
2 hydrogen atoms
F
+
F
F
F
fluorine molecule
2 fluorine atoms
2
O
+
C
O
C
O
carbon dioxide molecule
2 oxygen atoms
carbon atom
4
F
+
C
F
F
C
F
F
a molecule of carbon tetrafluoride
4 fluorine atoms
carbon atom

POLAR COVALENT-

Exs. H_2O-

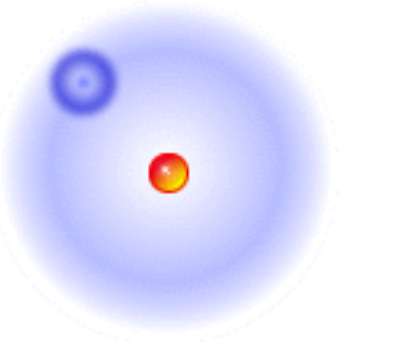
SO_2-

MOLECULE-

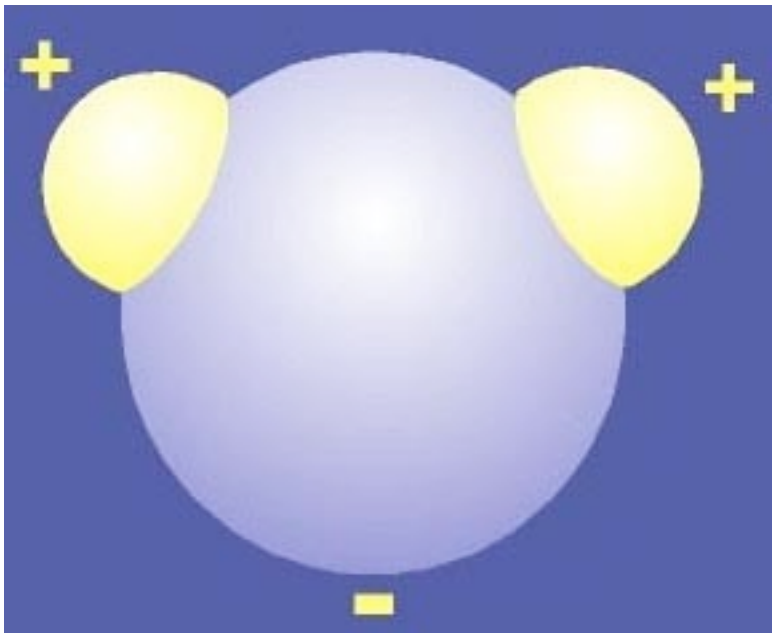
POLAR COVALENT-

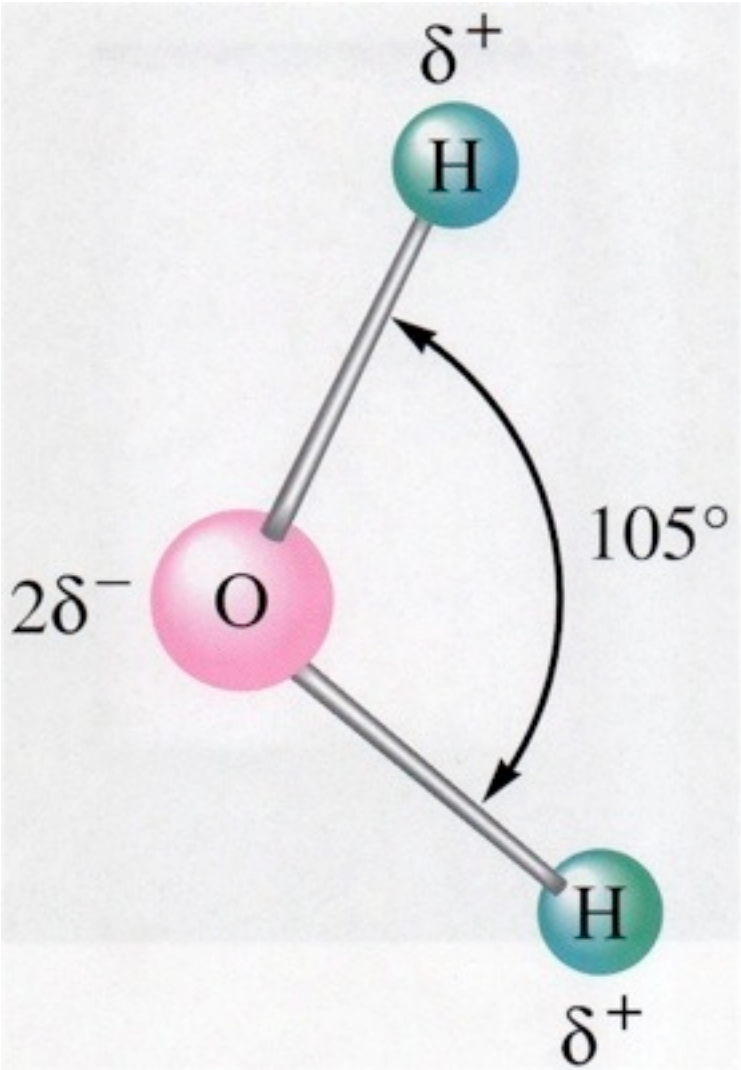
Exs. H_2O-

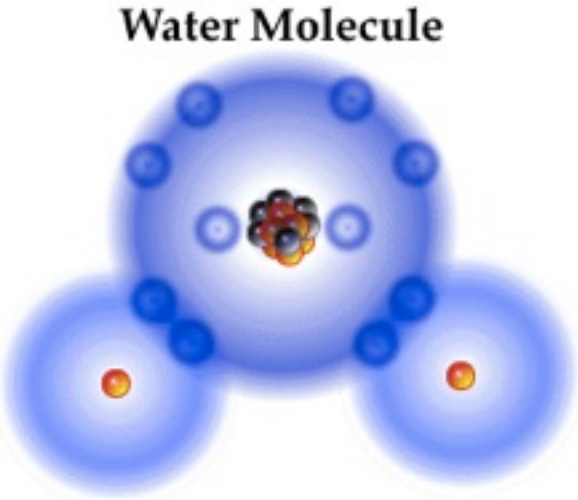
SO_2-

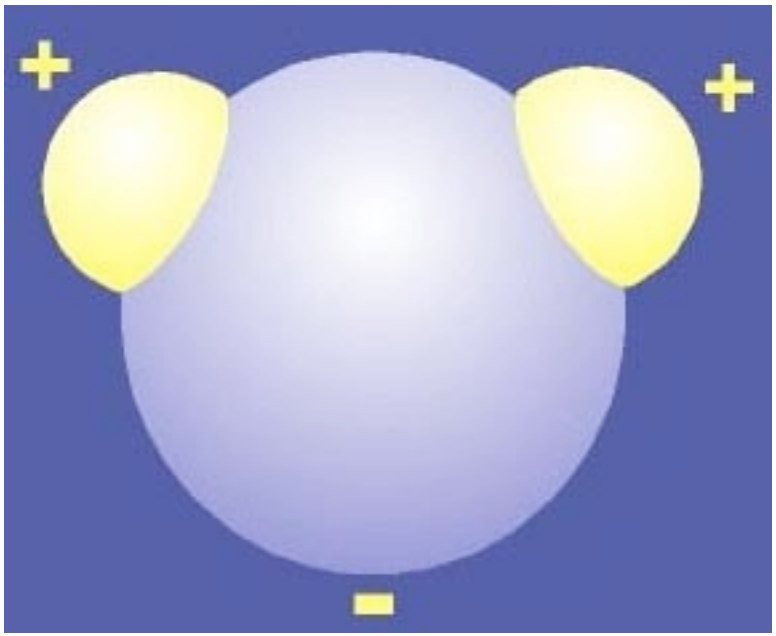


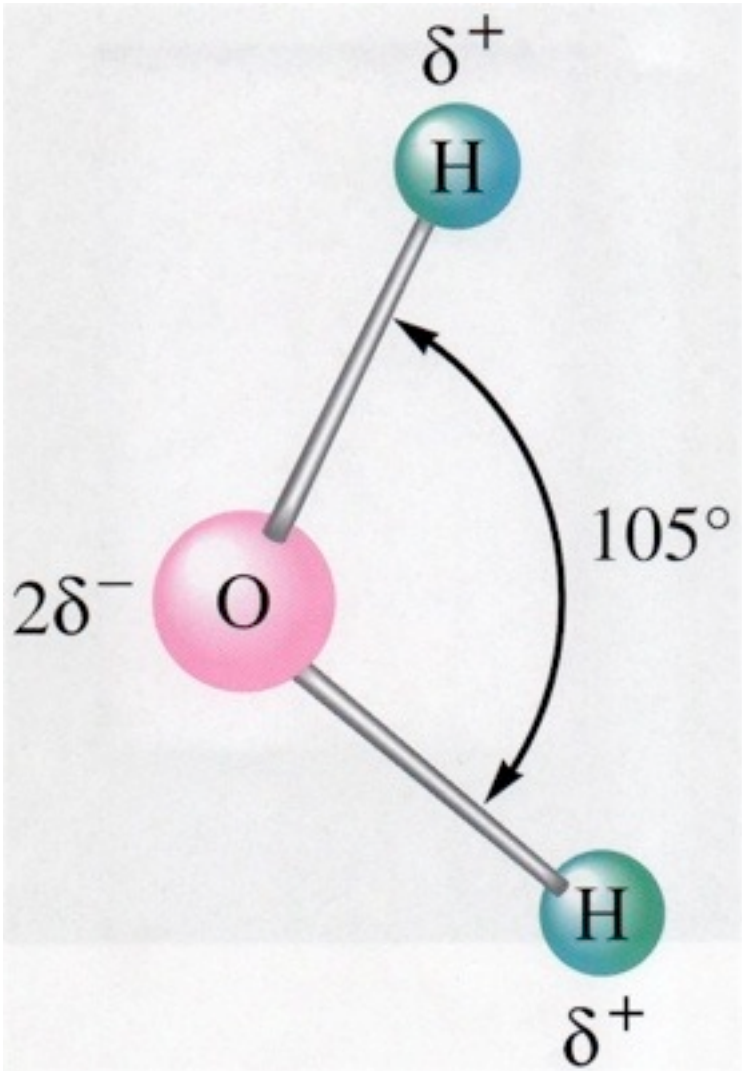
MOLECULE-


+
+
−


δ+
H
2δ−
O
105°
H
δ+

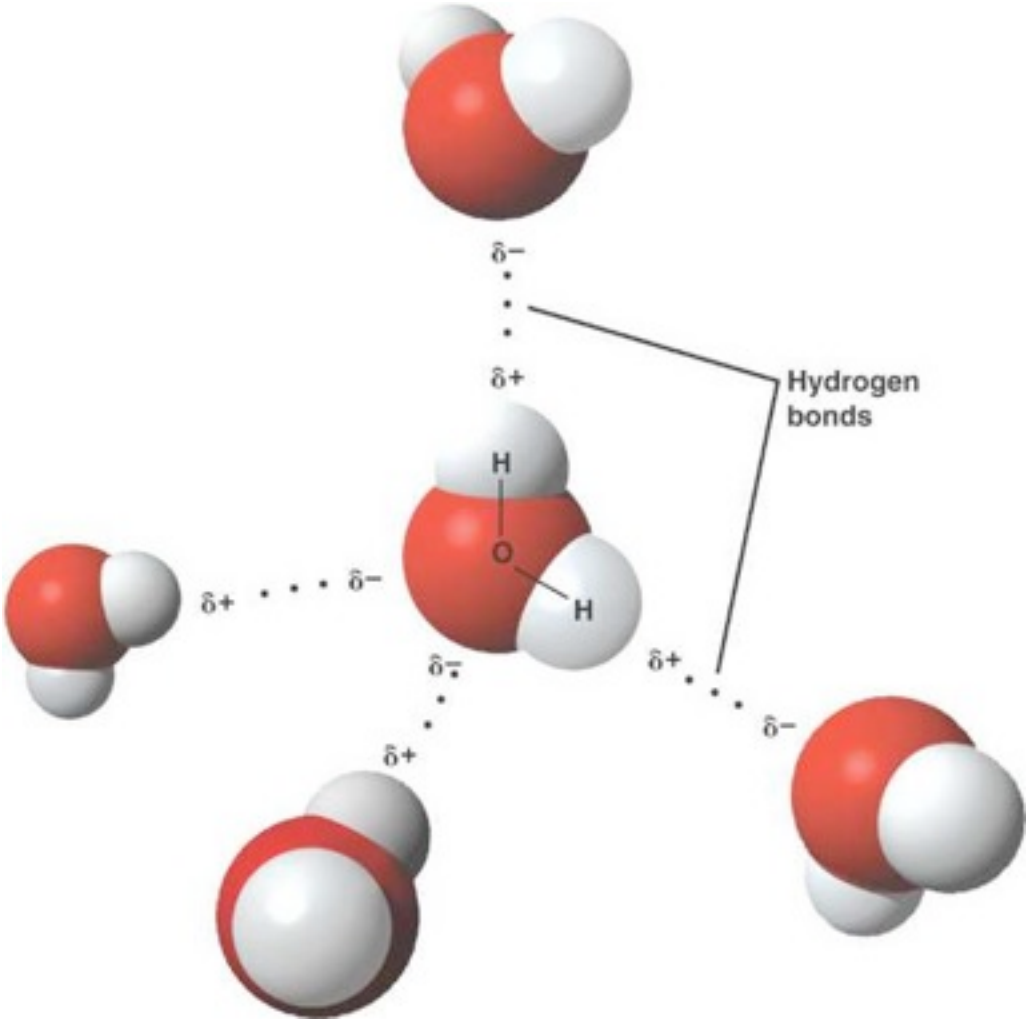

Water Molecule


+
+
−


δ+
H
2δ−
O
105°
H
δ+

C. Van der Waals Forces-

ex. Hydrogen Bond



III. Chemical Reactions

The rearrangement of atoms by making and/or breaking of covalent bonds.

Reactanct(s) ➔ Product(s)

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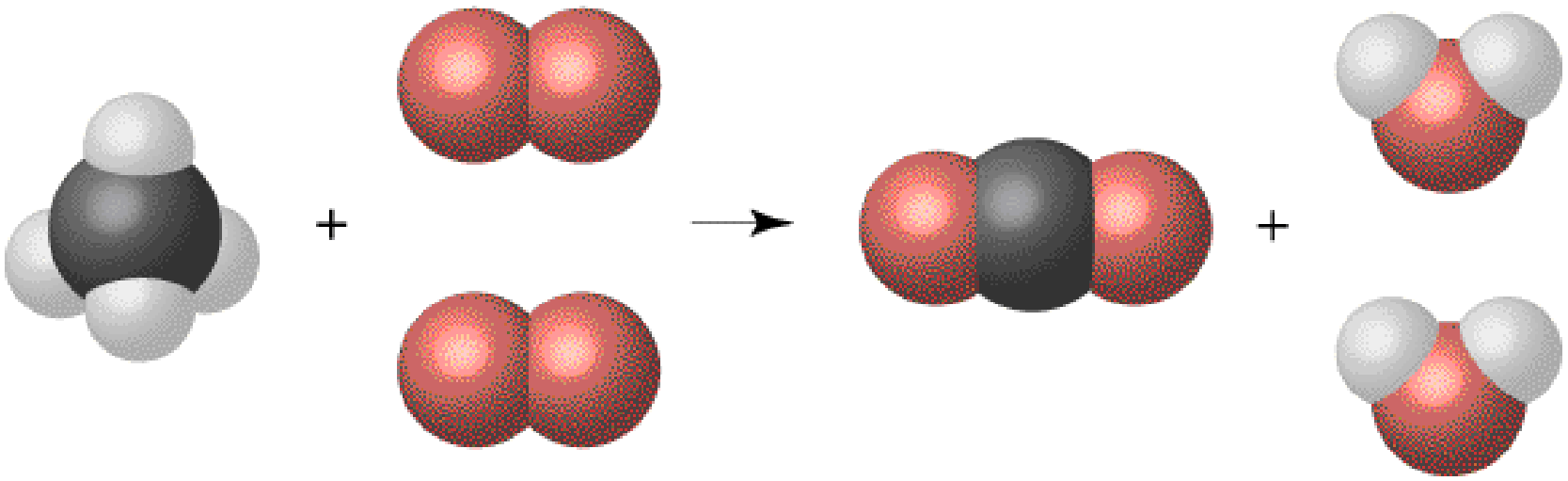
The rearrangement of atoms by making and/or breaking of covalent bonds.

Reactanct(s) ➔ Product(s)

Reactant(s) + *activation energy* ➔ Product(s)

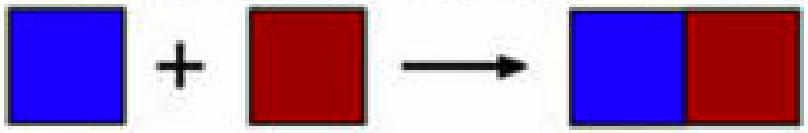


One methane molecule + Two oxygen molecules → One carbon dioxide molecule + Two water molecules

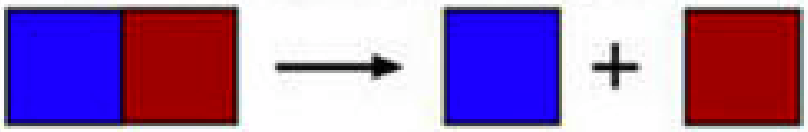
$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

(1 C, 4 H) (4 O) (1 C, 2 O) (2 O, 4 H)

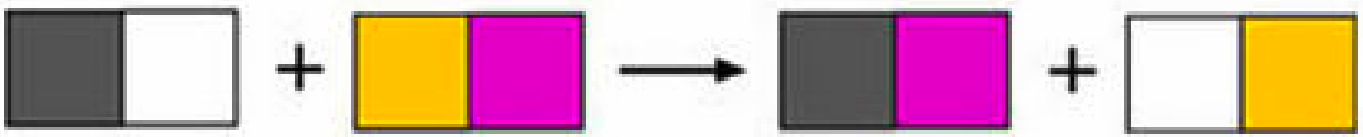
Particles combine to make new one



Particle breaks apart



Particle combinations changed



Catalyst

Reactant(s) + *activation energy* ➔ Product(s)

Catalyst

Reactant(s) + *activation energy* ➔ Product(s)

In life processes

Catalyst
Enzyme

Reactant(s) + *activation energy* ➔ Product(s)

In life processes

Catalyst
Enzyme

Reactant(s) + *activation energy* ➔ Product(s)
Substrate

In life processes

Catalyst
Enzyme

Reactant(s) + *activation energy* ➔ Product(s)
Substrate

In life processes

catalase

Ex. $2H_2O_2$ ➔ $2\ H_2O + O_2$

Title: The Effect of Food Color on Selection by Kindergarten Children

Hypothesis: If kindergarten children are given different colored food choices, then they will select the most appealing color.

IV: food color			
Red	Green	Yellow	Blue
100 trials	100 trials	100 trials	100 trials

DV: food color choice (number of children who select the color)

Constants: type of food (mashed potatoes)
food bowls (identical)
children (kindergarten age, same day and place)

Title: The Effect of Competition for Space on Marigold Seedling Height

Hypothesis: If seed competition for space increases, then seedling height will decrease.

IV: Number of seeds				
1 (control)	2	4	8	16
1 trial	1 trial	1 trial	1 trial	1 trial

DV: height of seedling (cm)

Constants: seeds (marigold)
potting soil (same type, same amount)
planters (same size plastic cups)
time of experiment (25 days)

WATER: Structure and Properties

H_2O

Polar

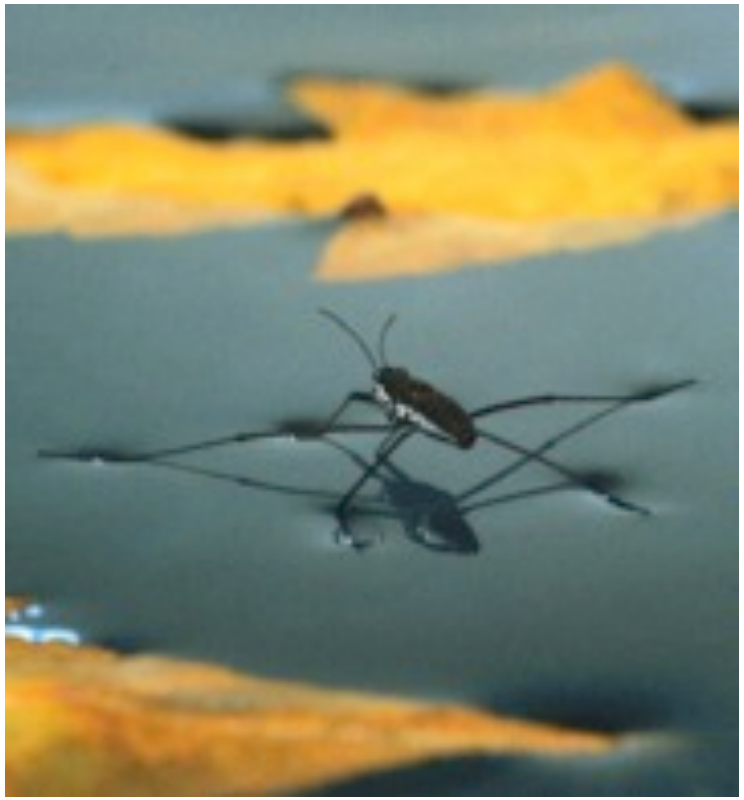
- Because water is polar it sticks to itself
- It also makes it accepting

II. Properties of Water

A. Cohesive-

1. creates surface tension-

Meaning for Living things?

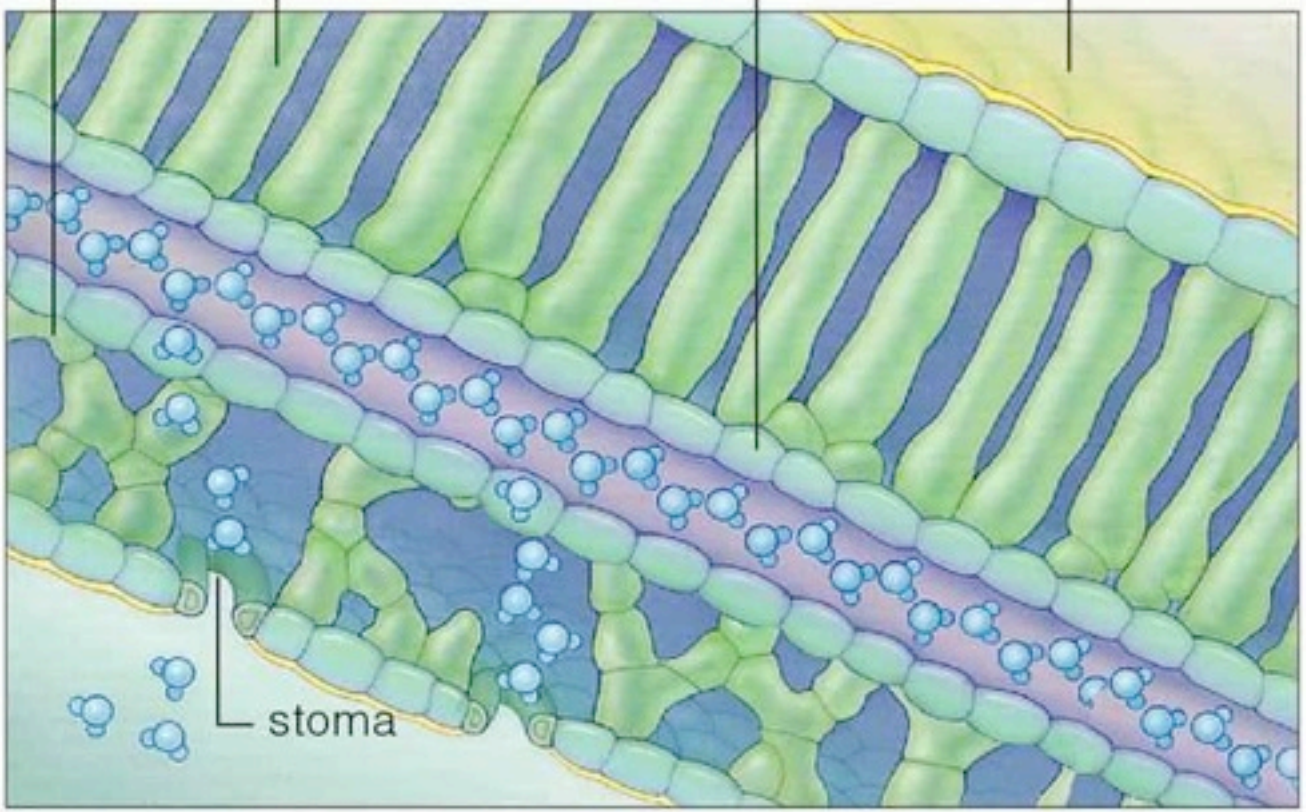


2. creates high tensile strength-

Meaning for living things?

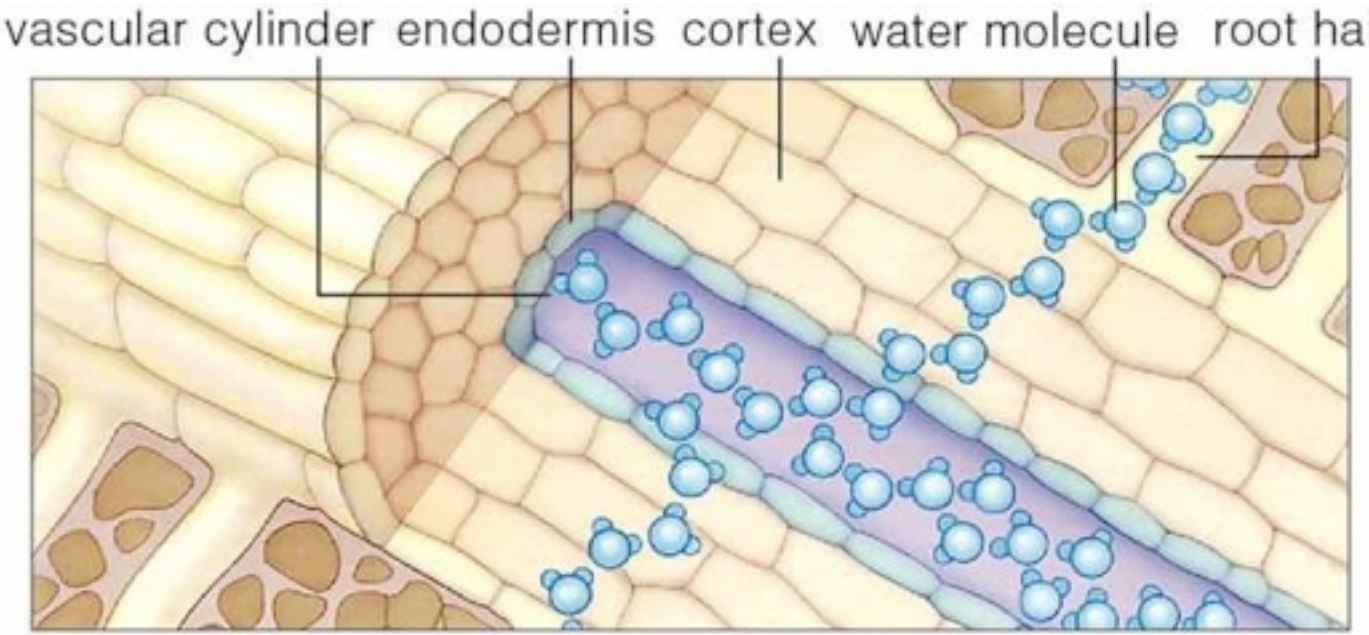
Cohesion-Tension

Explains the flow of water
Through the xylem of plants.



The driving force of evaporation in air

a Transpiration is the evaporation of water molecules from aboveground plant parts, especially at stomata. The process puts the water in xylem in a state of tension that extends from roots to leaves.



Ongoing w ater uptak e at r oots

C For as long as water molecules continue to escape by transpiration, that tension will drive the uptake of replacements from soil water.

THERMAL PROPERTIES

B. High Specific Heat-

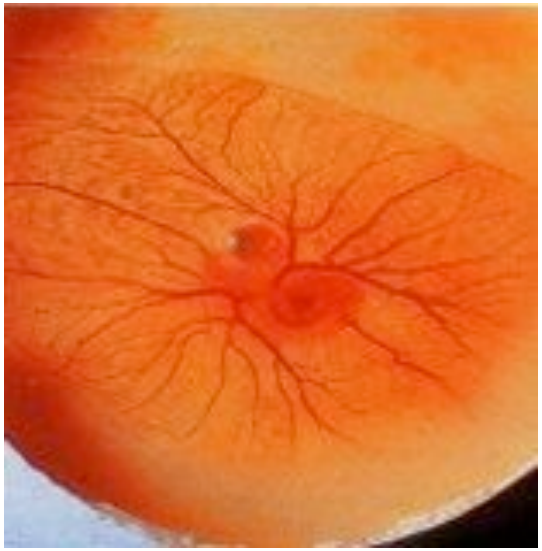
C. High Heat of Vaporization-

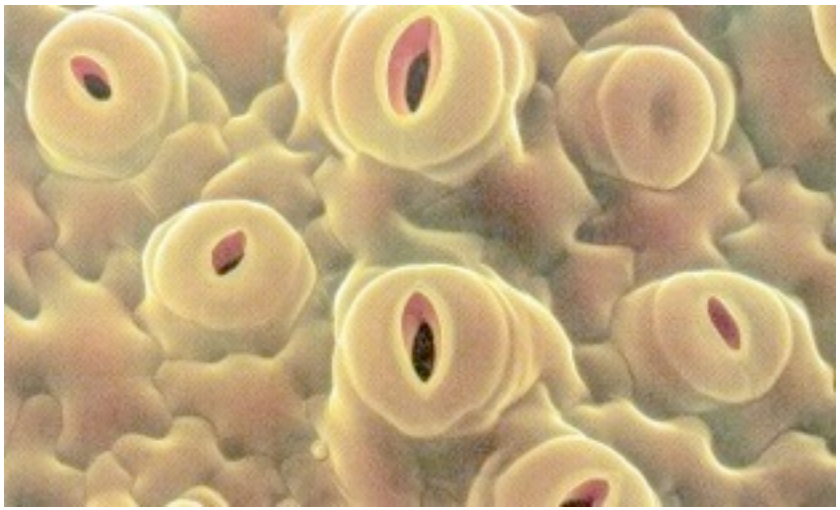
D. High Heat of Fusion-

Meaning for living things?

FOTO: MICHAEL GOULDING

Figura 1 - Tambaqui (Colossoma macropomum) se alimentando no igapó.





E. “Universal” Solvent

What can <u>dissolve</u> in water?

1.

exs.

2.

exs.

What can’t?

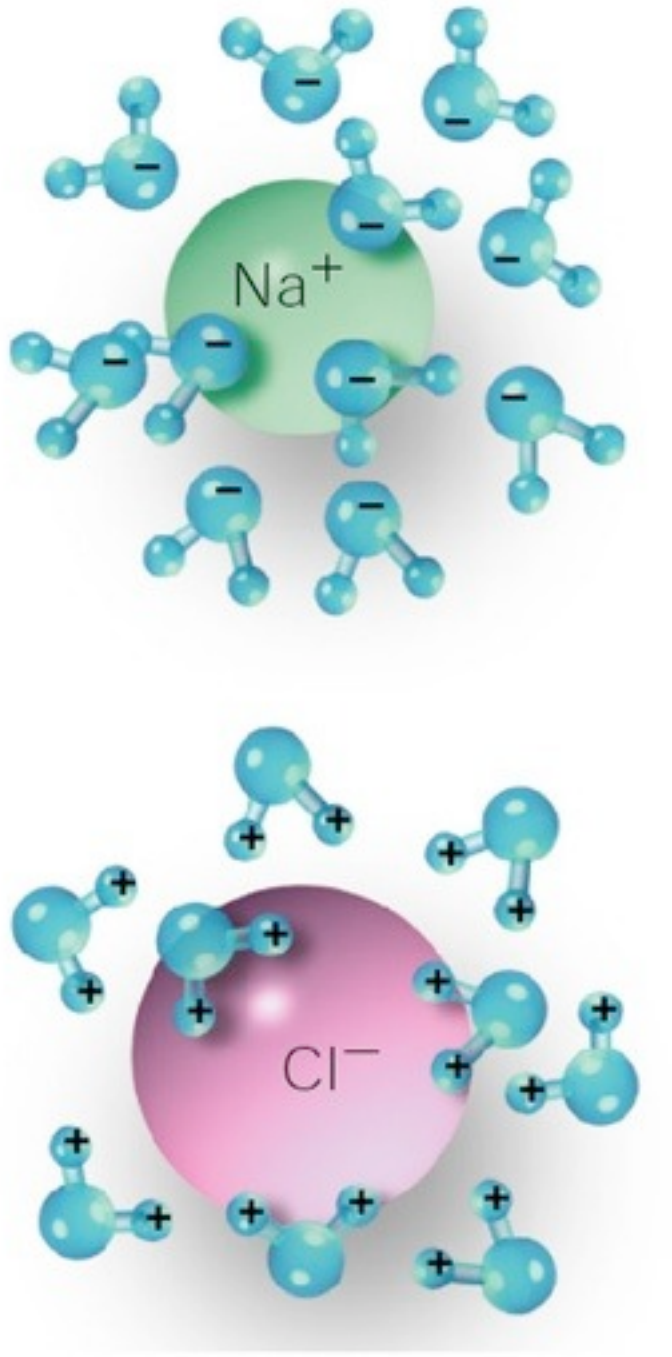
1.

exs.

2.

exs.

Meaning for living things?



F. Transparent-

Meaning for living things?

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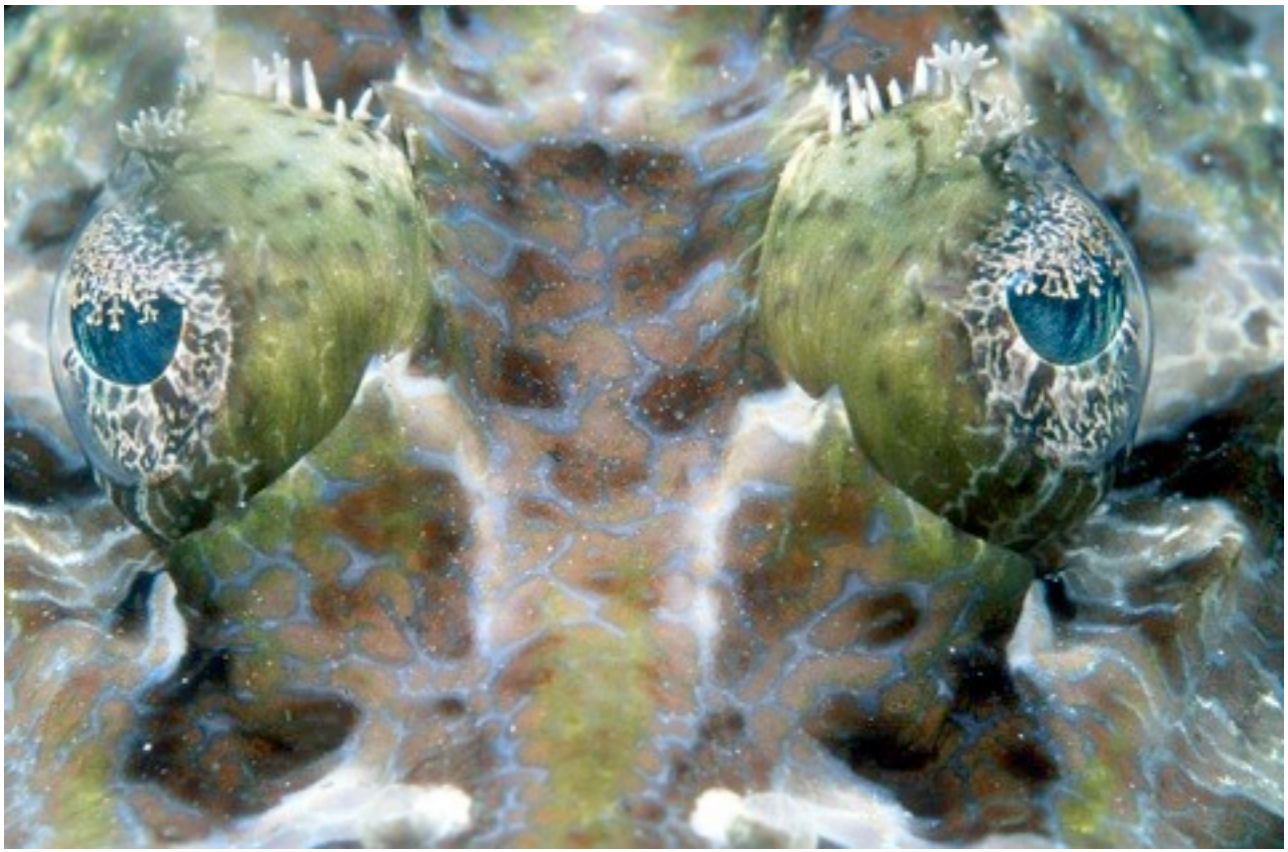
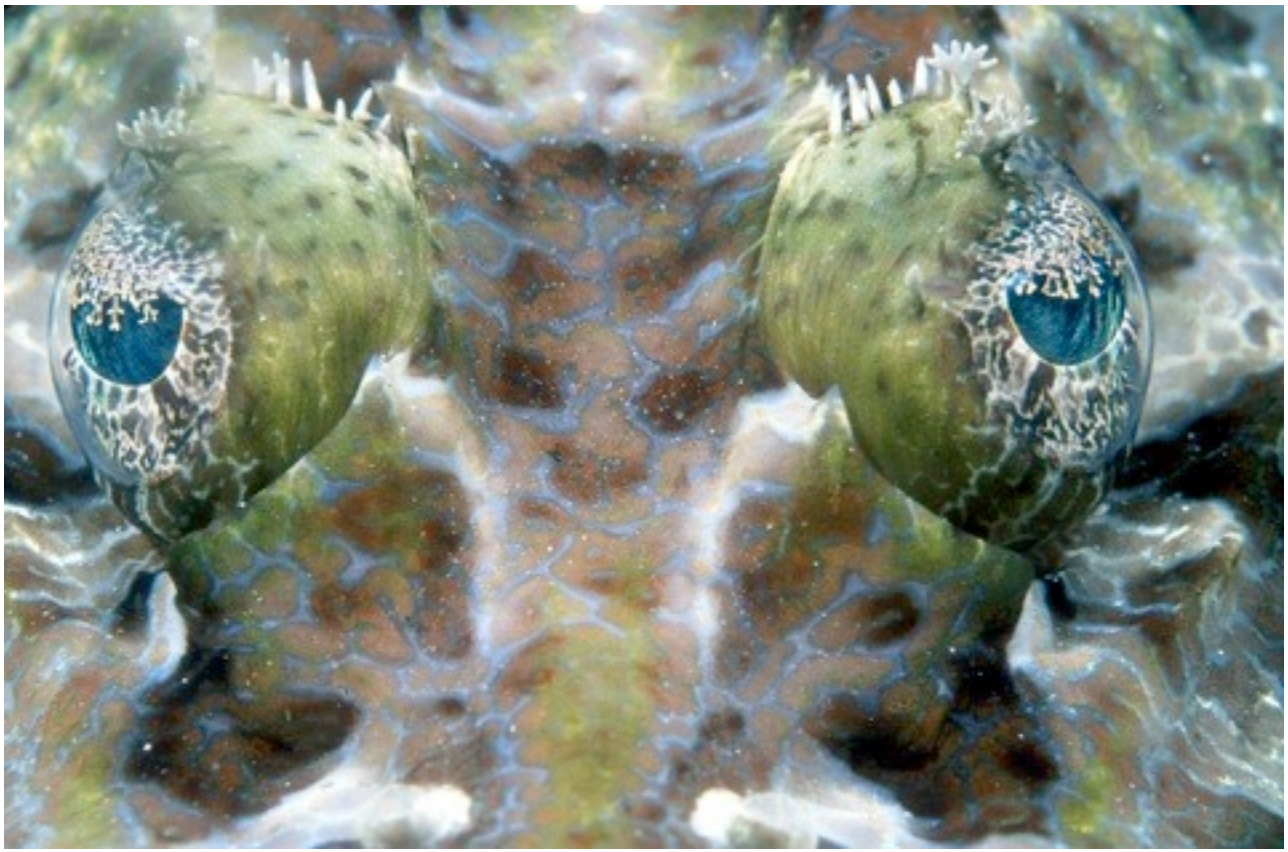


F. <u>Transparent</u>-

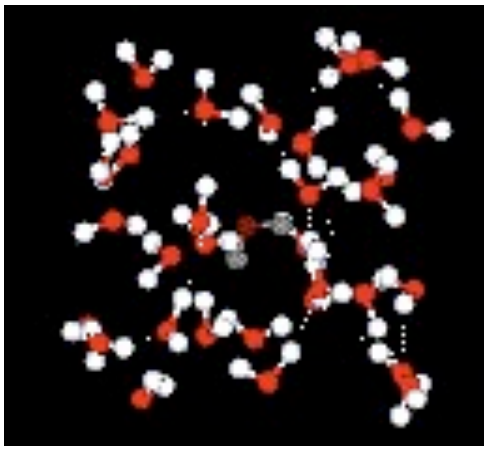
Meaning for living things?

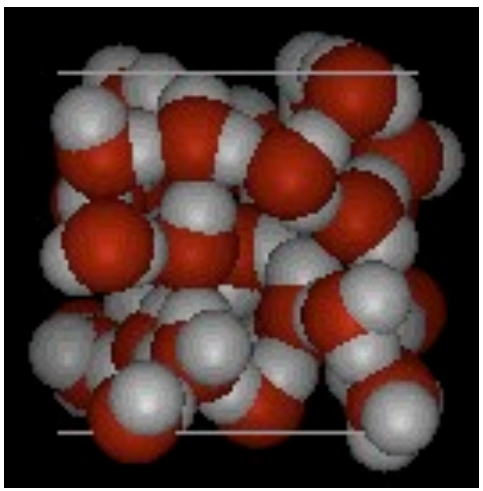


G. Ice is Less Dense than Water Why?

G. Ice is Less Dense than Water Why?

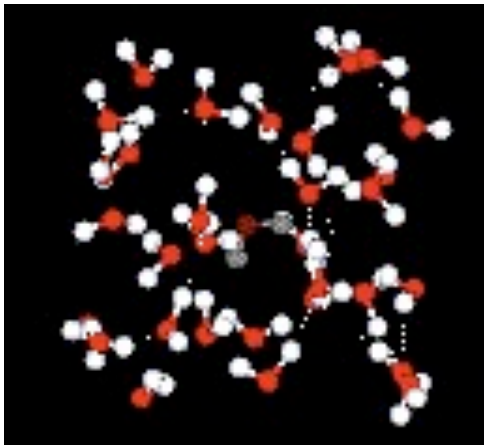
Water

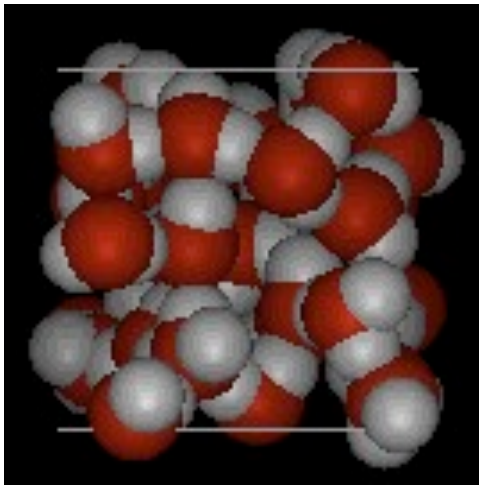




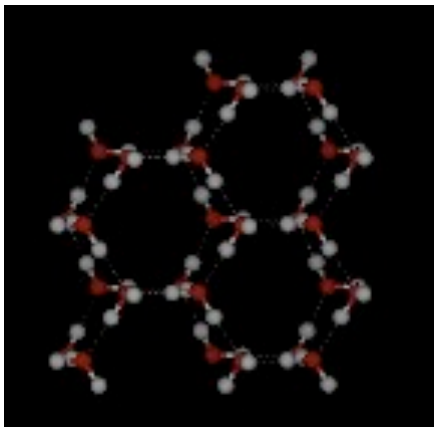
G. Ice is Less Dense than Water Why?

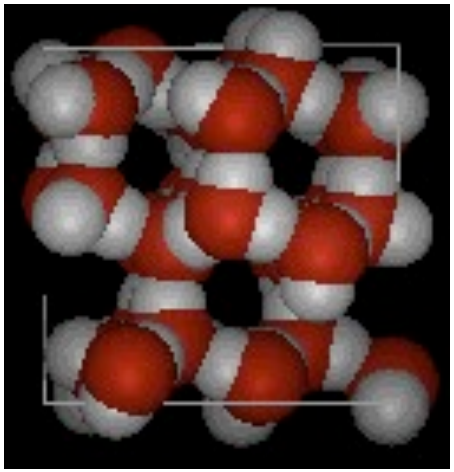
Water





Ice



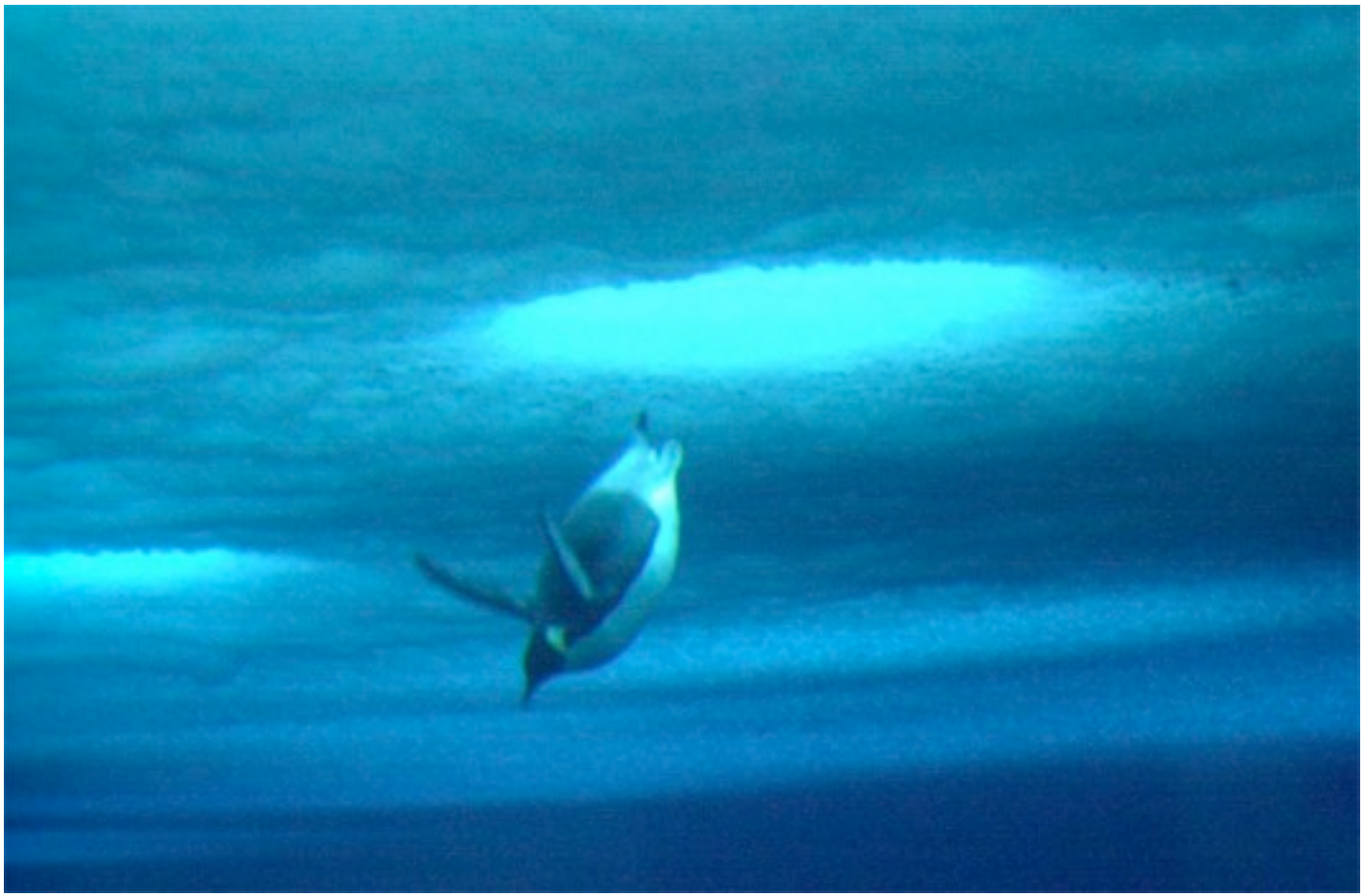


What happens if you squeeze ice?

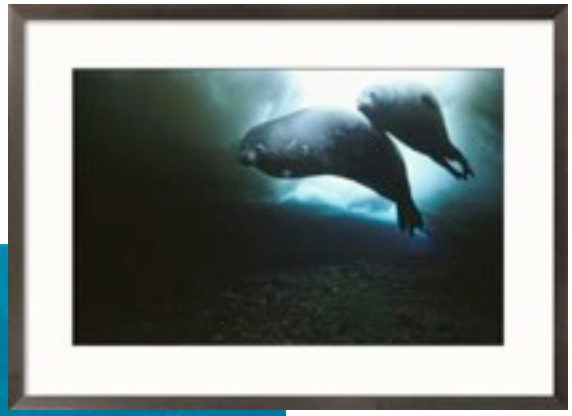
What happens if you squeeze ice?

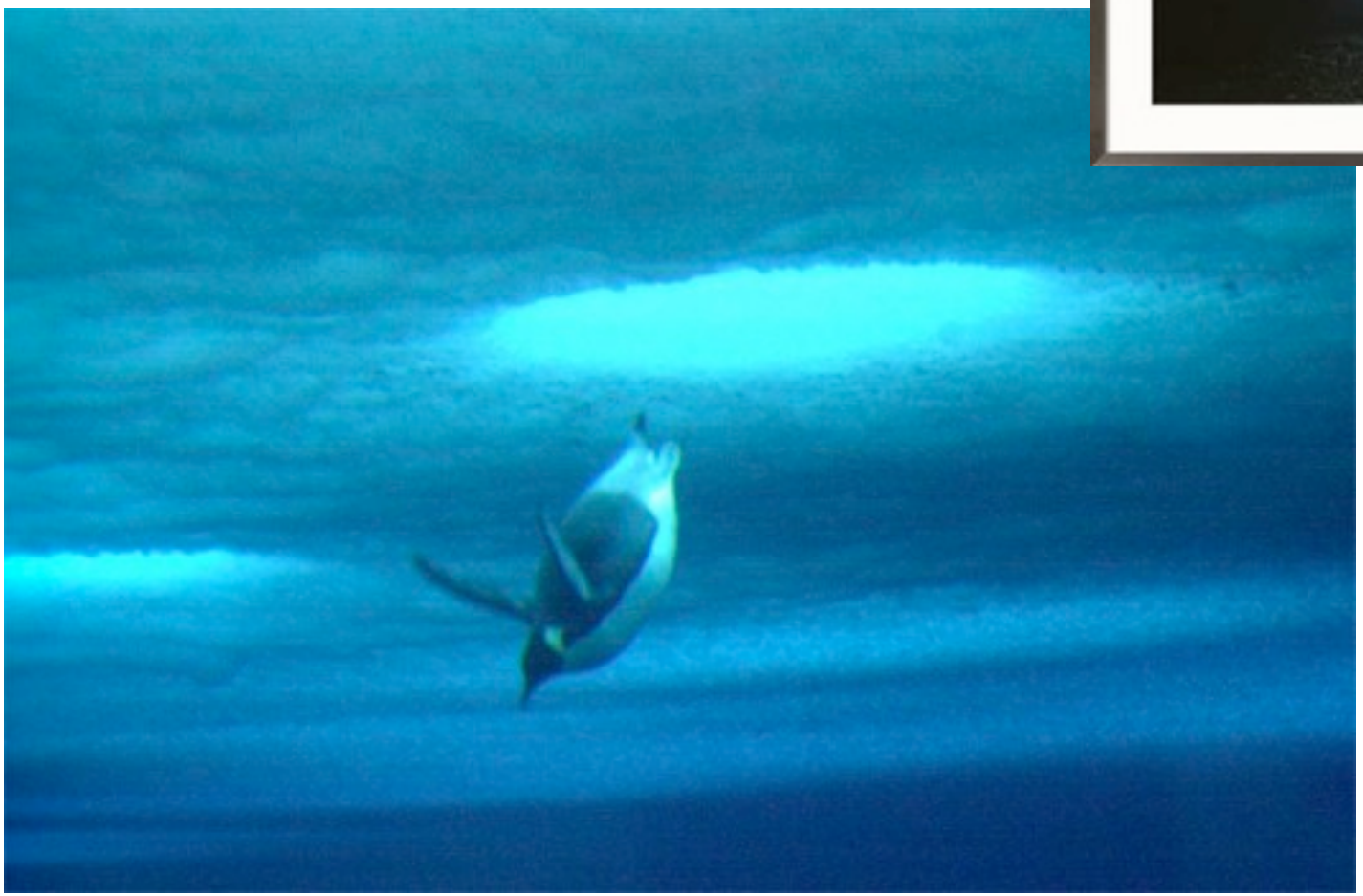
Meaning for living things?

Meaning for living things?



Meaning for living things?





Where is all the water?

Water Source	Percent of Total Water
Oceans	97.24
Icecaps, Glaciers	2.14
Ground Water	0.61
Fresh Water Lakes	0.009
Inland Seas	0.008
Soil Moisture	0.005
Atmosphere	0.001
Rivers	0.0001
Total Water Volume	100

Sources: U.S. Geological Surveys, 1967 and 1984

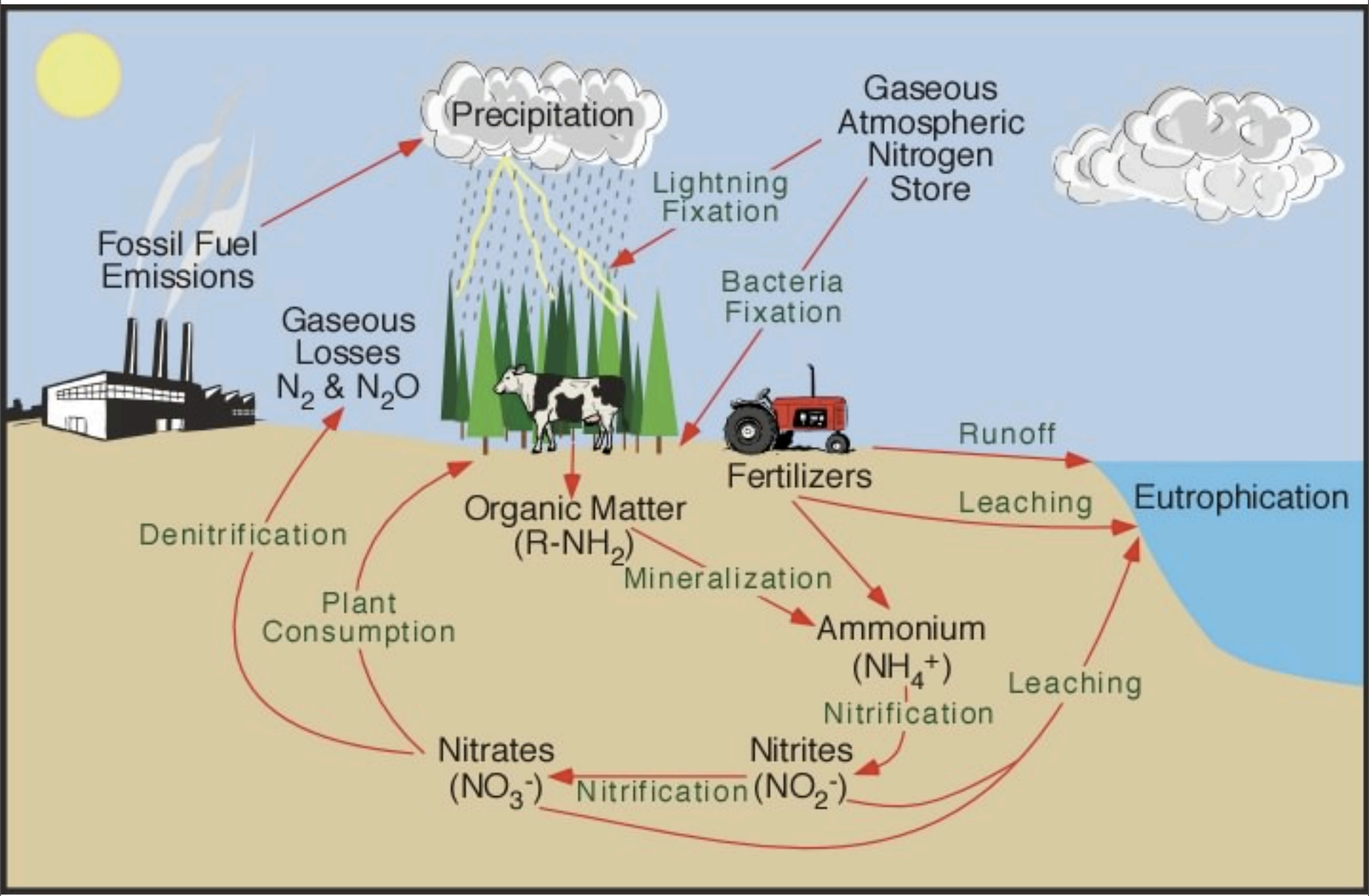
Where did all the water come from?

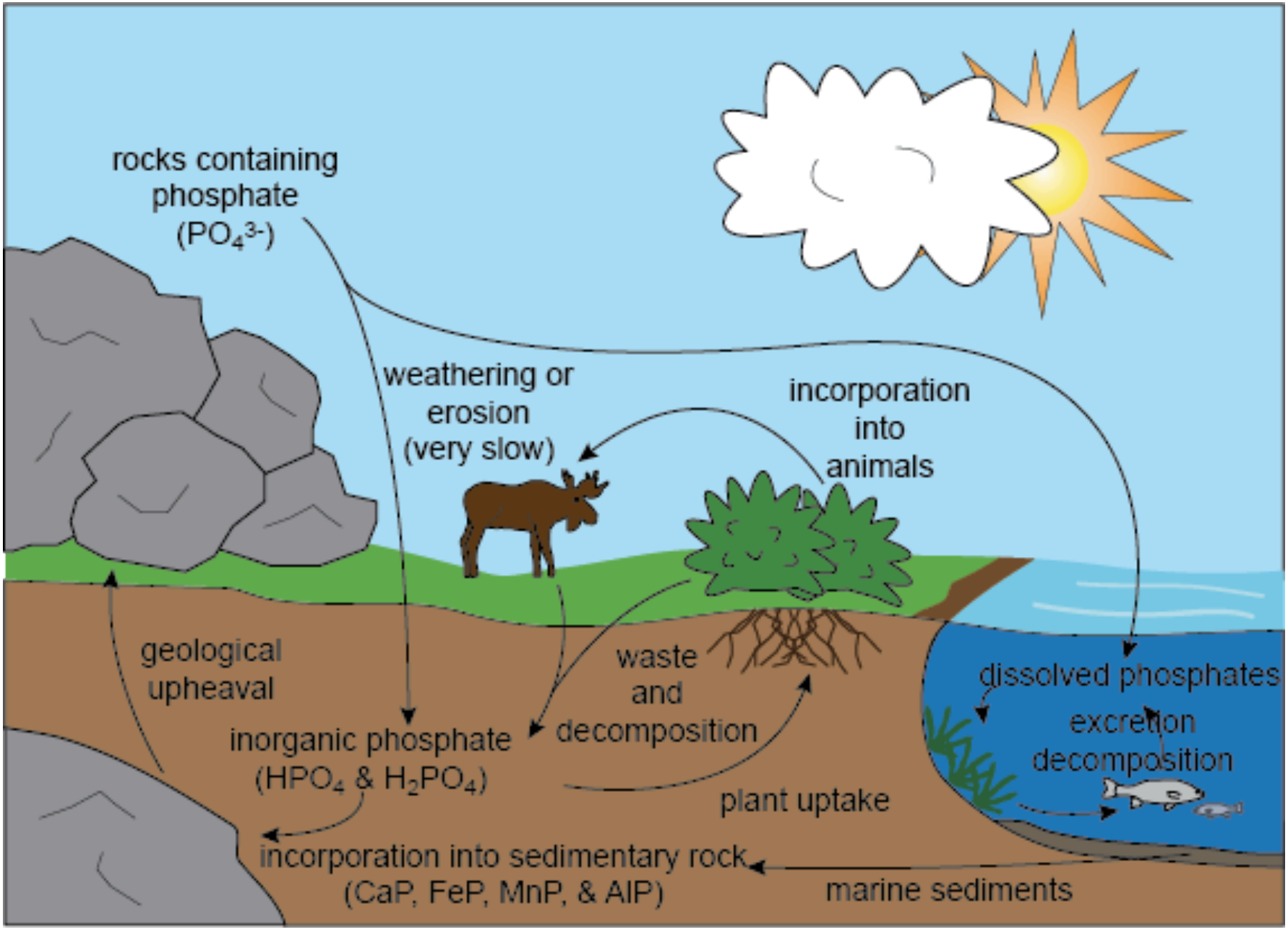
Where did all the water come from?

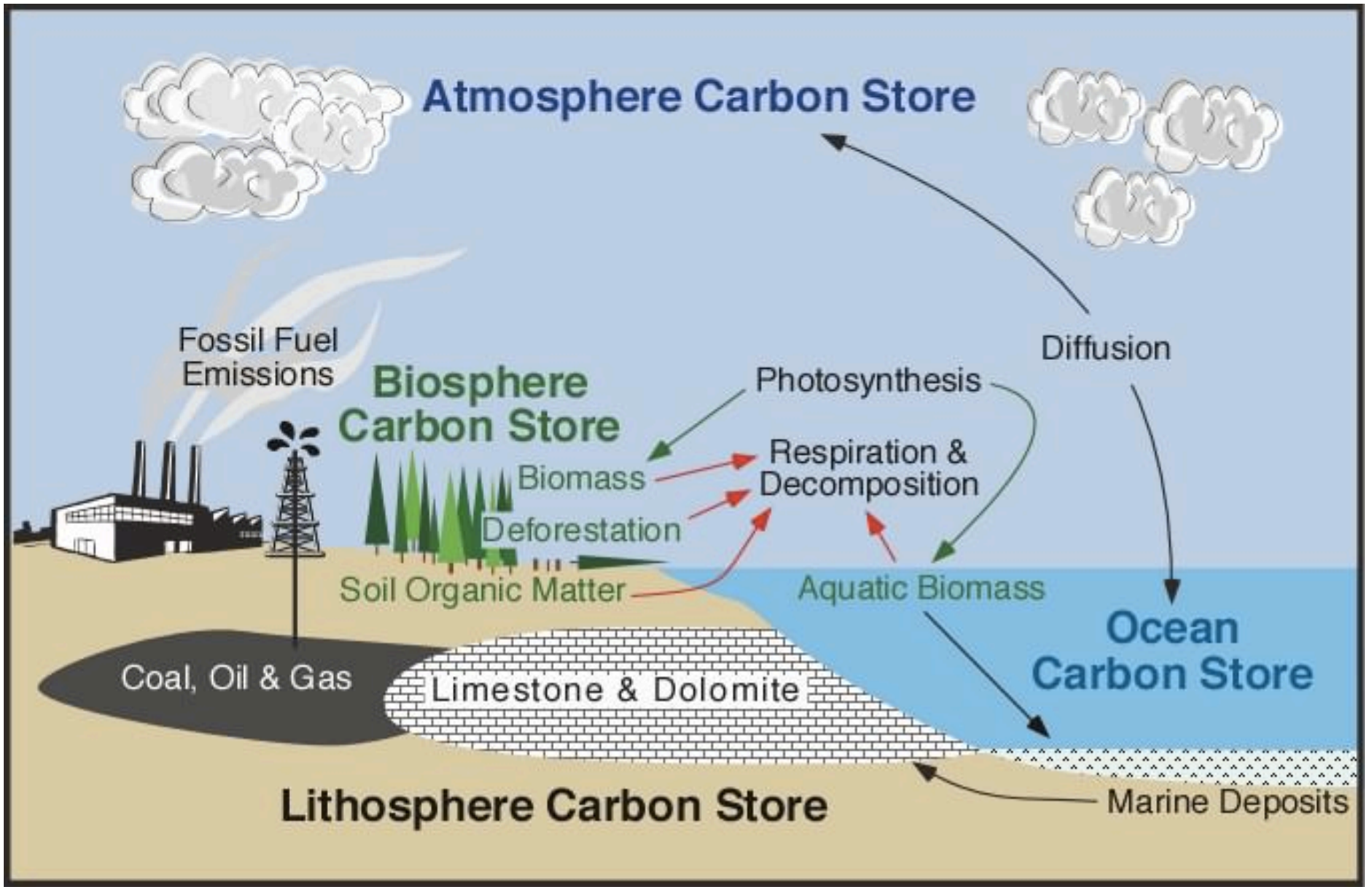
National Geographic, May 2004
Joel Achenback, Washington Post

Water is the lubricant, the grease that makes biochemistry possible. Water has given us oceans, clouds, rivers, lakes- and it helps shape everything alive on Earth. So the next time you stand on a beach and admire the beauty and vastness of the sea, or marvel at a seashell, remind yourself; It's all brought to you by the hydrogen bond.


USGS
science for a changing world
The water cycle describes how Earth's water is not only always changing forms, between liquid, solid (ice), and gas (vapor), but also moving on, above, and in the Earth. This process is always happening everywhere.
SUN
CONDENSATION
ICE AND SNOW
PRECIPITATION
The Water Cycle
EVAPORATION
SNOWMELT
RUNOFF
RIVERS
H_2O
OCEANS
SPRINGS
PLANTS
LAKES
SEEPAGE
GROUNDWATER
U.S. Department of the Interior
U.S. Geological Survey
Stefanie Nens, Jim Morgan, Gabriele Zanolli, Food and Agriculture Organization of the United Nations
Howard Perlman, Gerard Gonthier, U.S. Geological Survey
General Information Product 146
http://ga.water.usgs.gov/edu/watercycle-kids.html


Precipitation
Gaseous Atmospheric Nitrogen Store
Lightning Fixation
Fossil Fuel Emissions
Bacteria Fixation
Gaseous Losses N_2 & N_2O
Runoff
Fertilizers
Eutrophication
Leaching
Organic Matter ($R\text{-}NH_2$)
Denitrification
Mineralization
Plant Consumption
Ammonium (NH_4^+)
Leaching
Nitrification
Nitrates (NO_3^-)
Nitrites (NO_2^-)
Nitrification


rocks containing phosphate (PO_4^{3-})
weathering or erosion (very slow)
incorporation into animals
geological upheaval
waste and decomposition
dissolved phosphates
excretion decomposition
inorganic phosphate (HPO_4 & H_2PO_4)
plant uptake
incorporation into sedimentary rock (CaP, FeP, MnP, & AlP)
marine sediments


Atmosphere Carbon Store
Fossil Fuel Emissions
Biosphere Carbon Store
Photosynthesis
Diffusion
Respiration & Decomposition
Biomass
Deforestation
Soil Organic Matter
Aquatic Biomass
Ocean Carbon Store
Coal, Oil & Gas
Limestone & Dolomite
Marine Deposits
Lithosphere Carbon Store