Propriedades Físico-Químicas da Água – O Líquido da Química e da Vida

QG 101

Marcos N. Eberlin

Planeta Água

GEM DISCOVERY

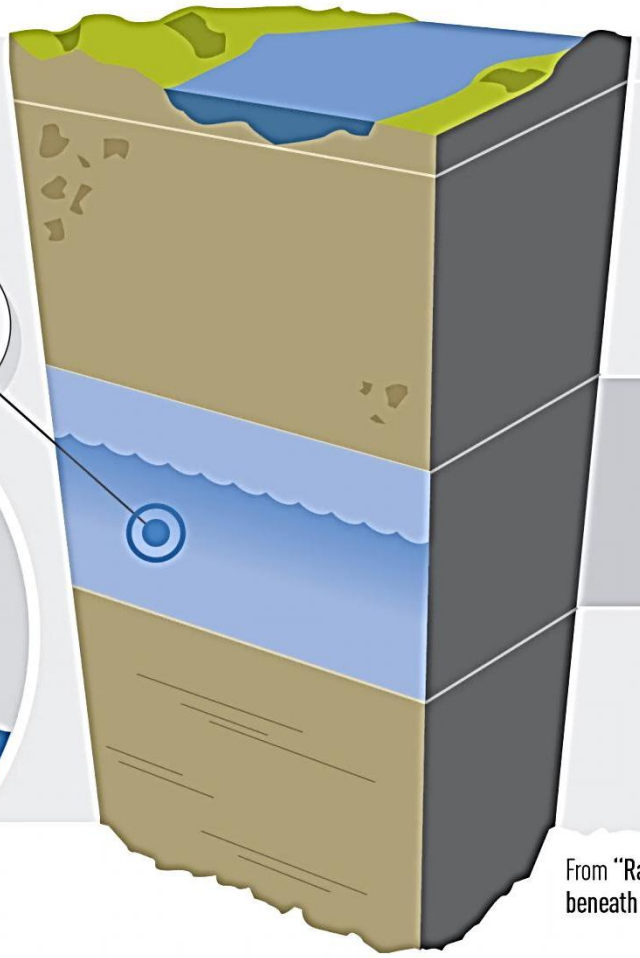
POINTS TO SUBTERRANEAN OCEANS

MINERAL:
RINGWOODITE

hidden within
DIAMOND

FIRST TIME
found in Earth

1.5 % WEIGHT
=WATER



UNIVERSITY OF ALBERTA

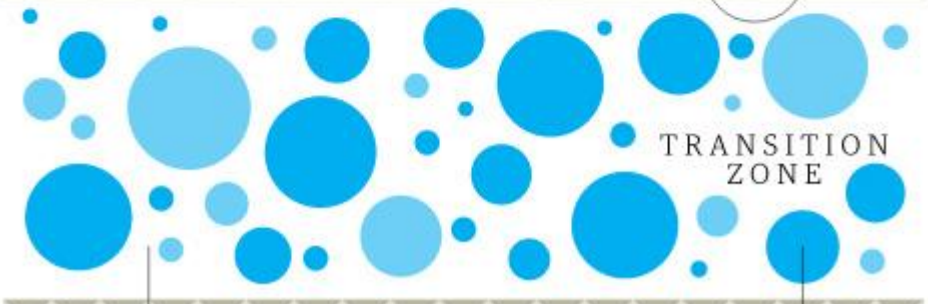
From "Rare mineral points to vast 'oceans' beneath the Earth" ow.ly/u6BuC

Bubbling under The Ringwoodite reservoir

1
Volcanoes cause **geological activity on the Earth's surface** which may affect areas deep underground

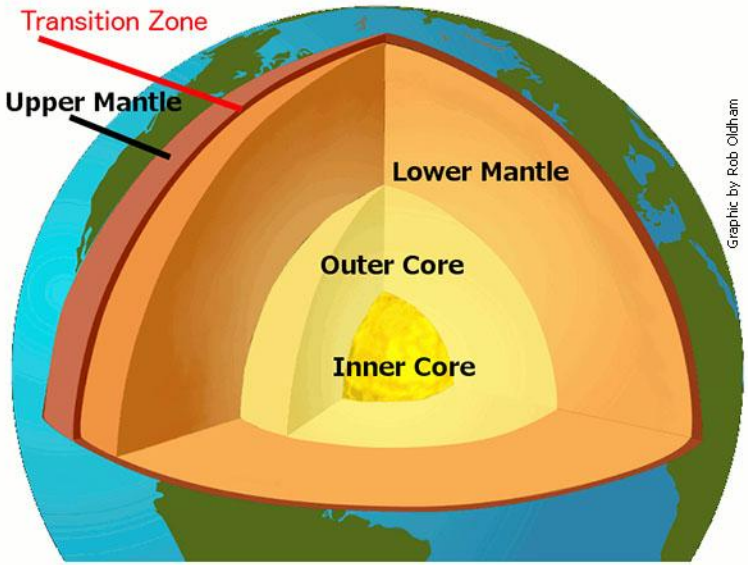
2
Three times the amount of water found in Earth's oceans **may be locked up in a mineral called ringwoodite**, found 660km (400 miles) beneath the Earth

3
Earth's water may have come from within, **driven to the surface by geological activity, rather than being deposited by icy comets** hitting the forming planet

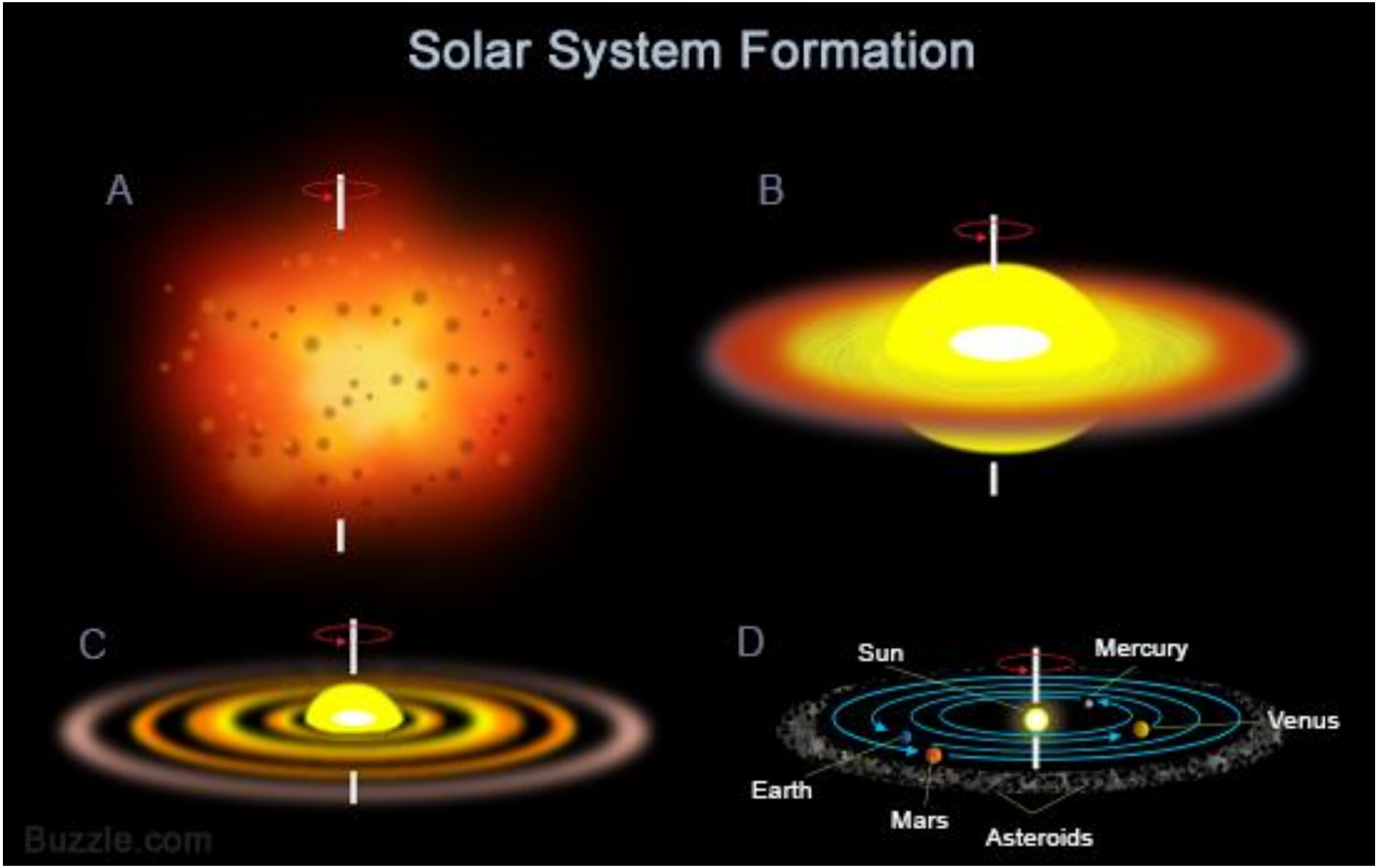


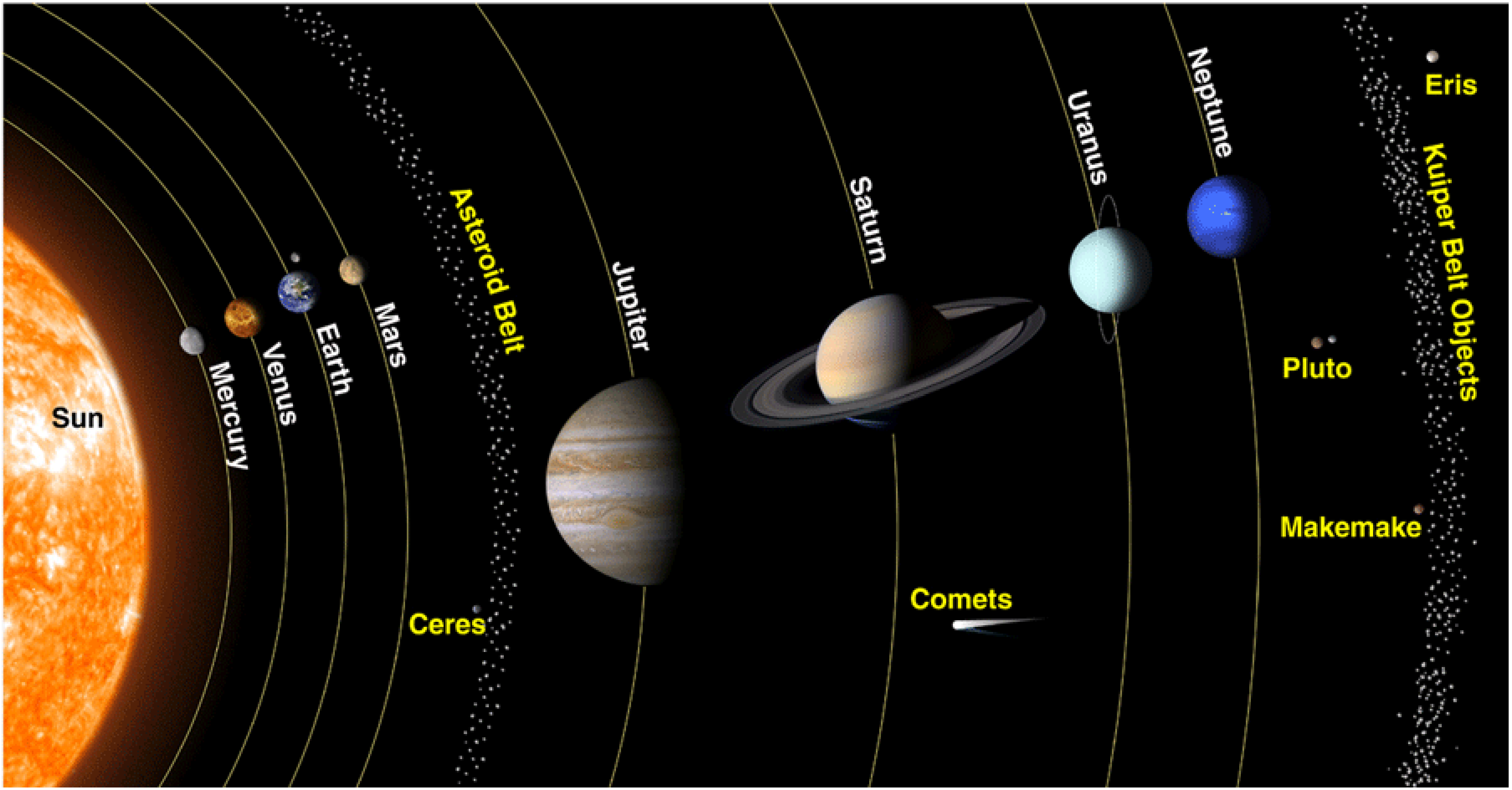
GRAPHIC: CATH LEVETT

SOURCE: SCIENCEMAG.ORG

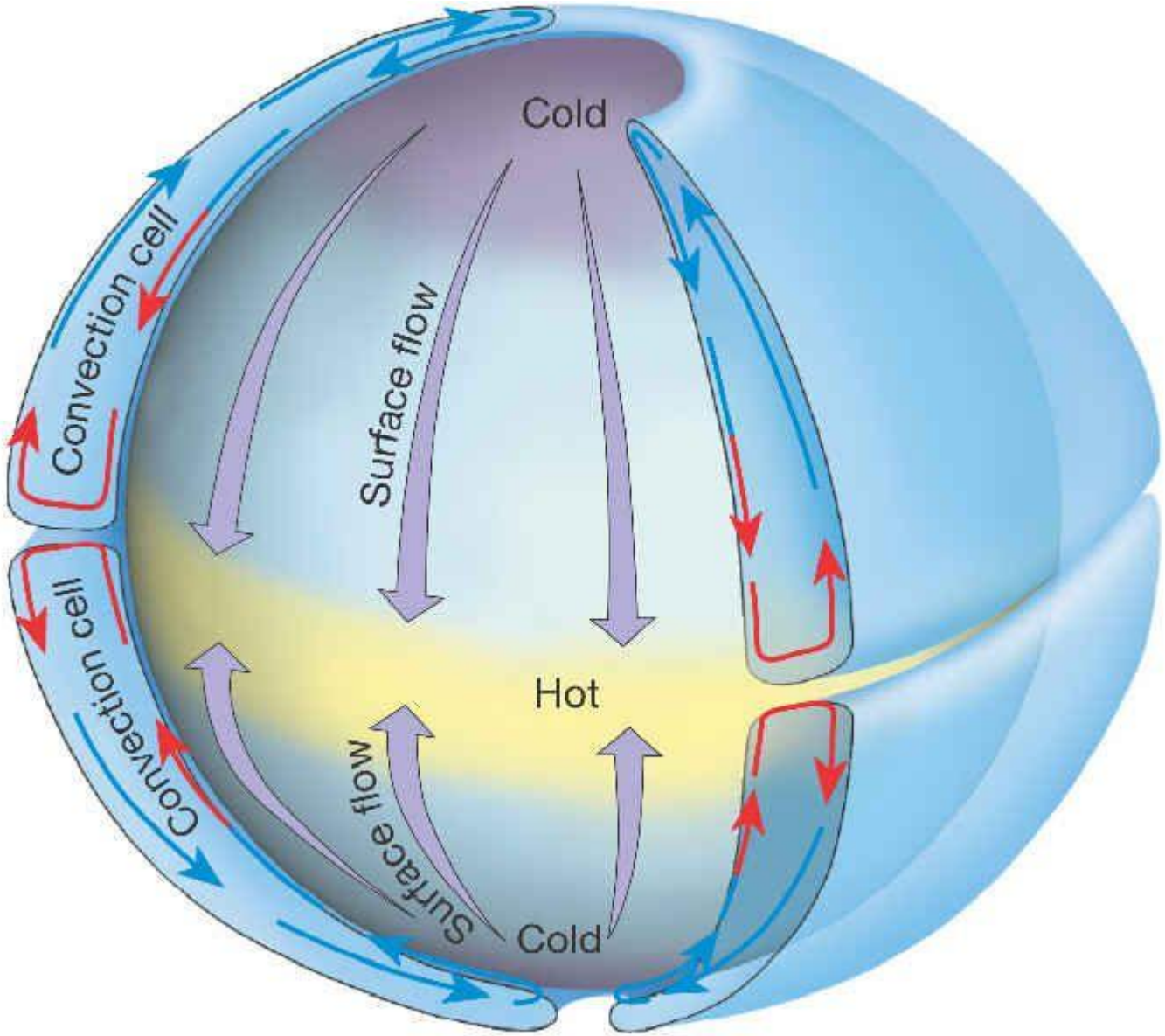


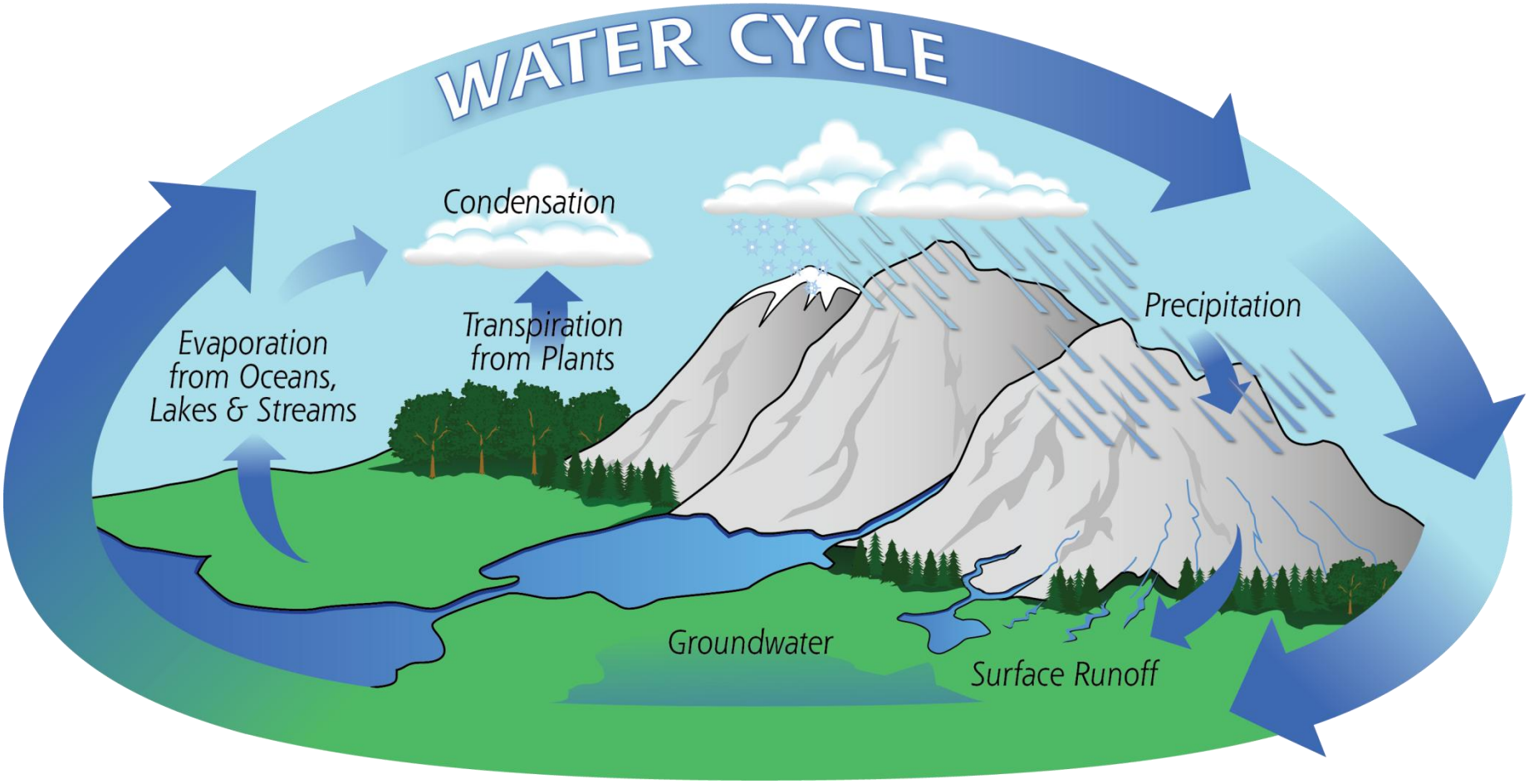
The transition zone is located between the upper and lower mantle sections from approximately 410-660km depth. Researchers from the University of Alberta believe there could be oceans of water there.

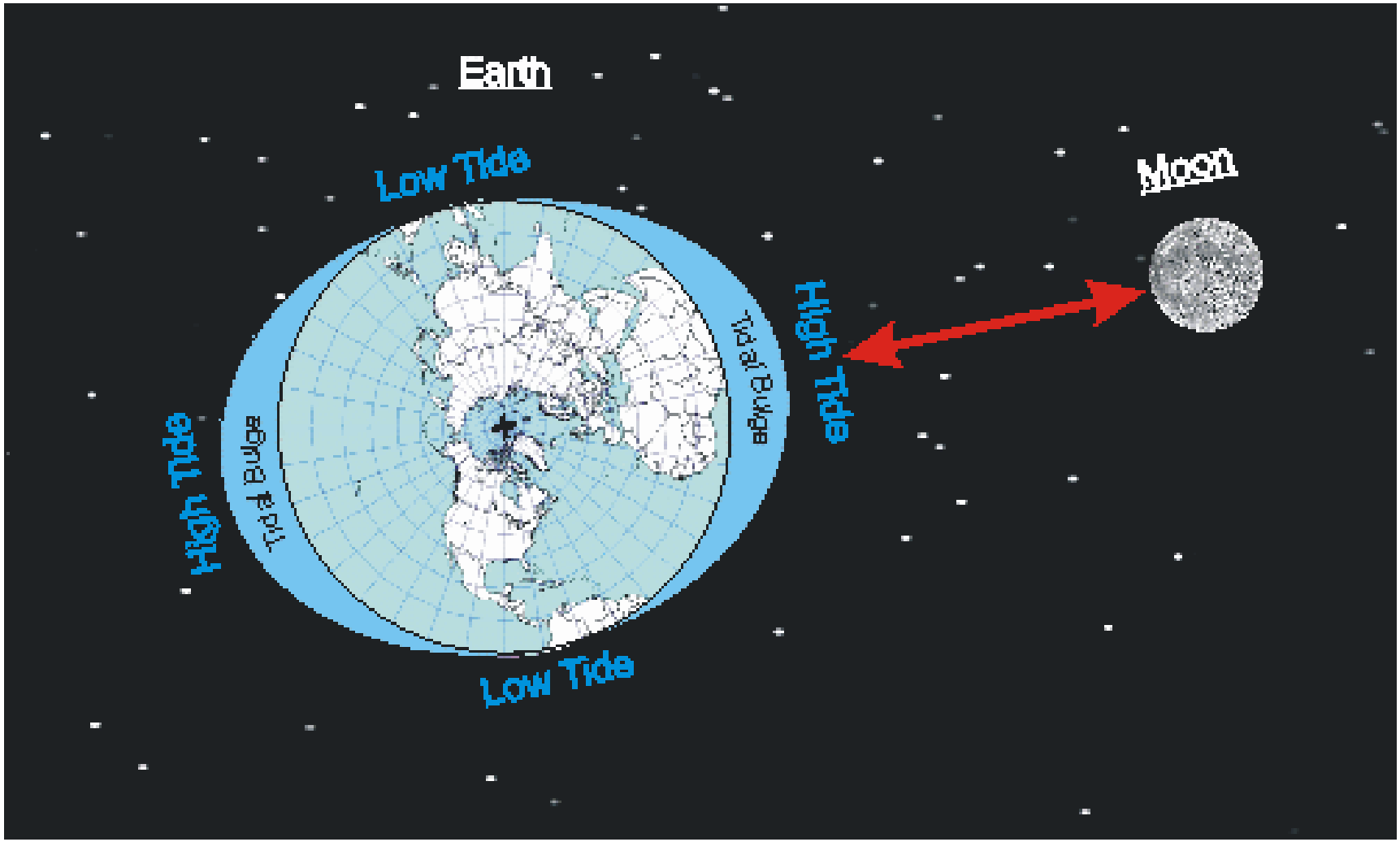

Solar System Formation
A
B
C
D
Sun
Mercury
Venus
Earth
Mars
Asteroids
Buzzle.com

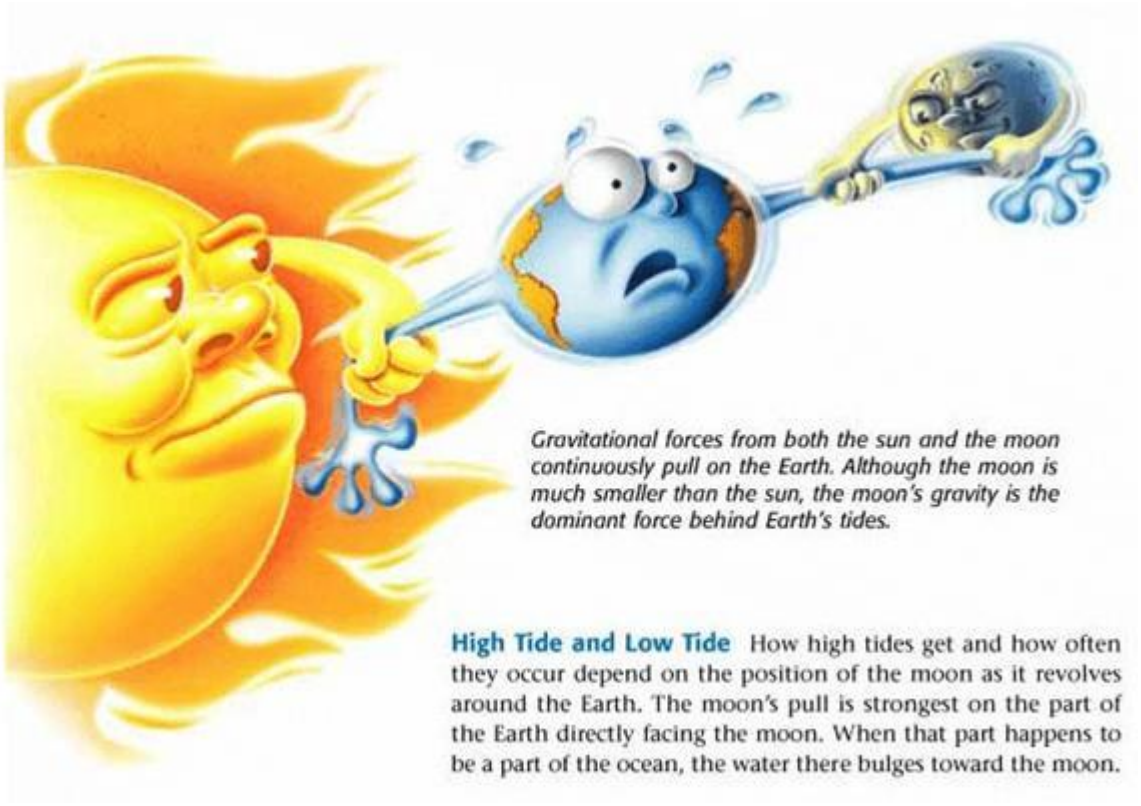


Sun
Mercury
Venus
Earth
Mars
Asteroid Belt
Ceres
Jupiter
Saturn
Comets
Uranus
Neptune
Pluto
Makemake
Eris
Kuiper Belt Objects


Cold
Convection cell
Surface flow
Convection cell
Hot
Surface flow
Cold

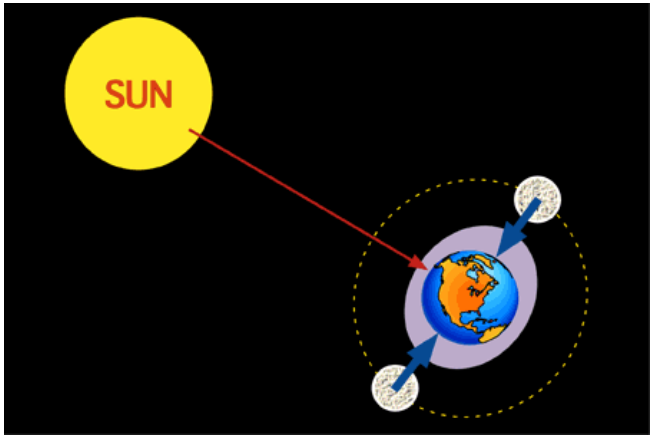

WATER CYCLE
Condensation
Transpiration
from Plants
Evaporation
from Oceans,
Lakes & Streams
Precipitation
Groundwater
Surface Runoff

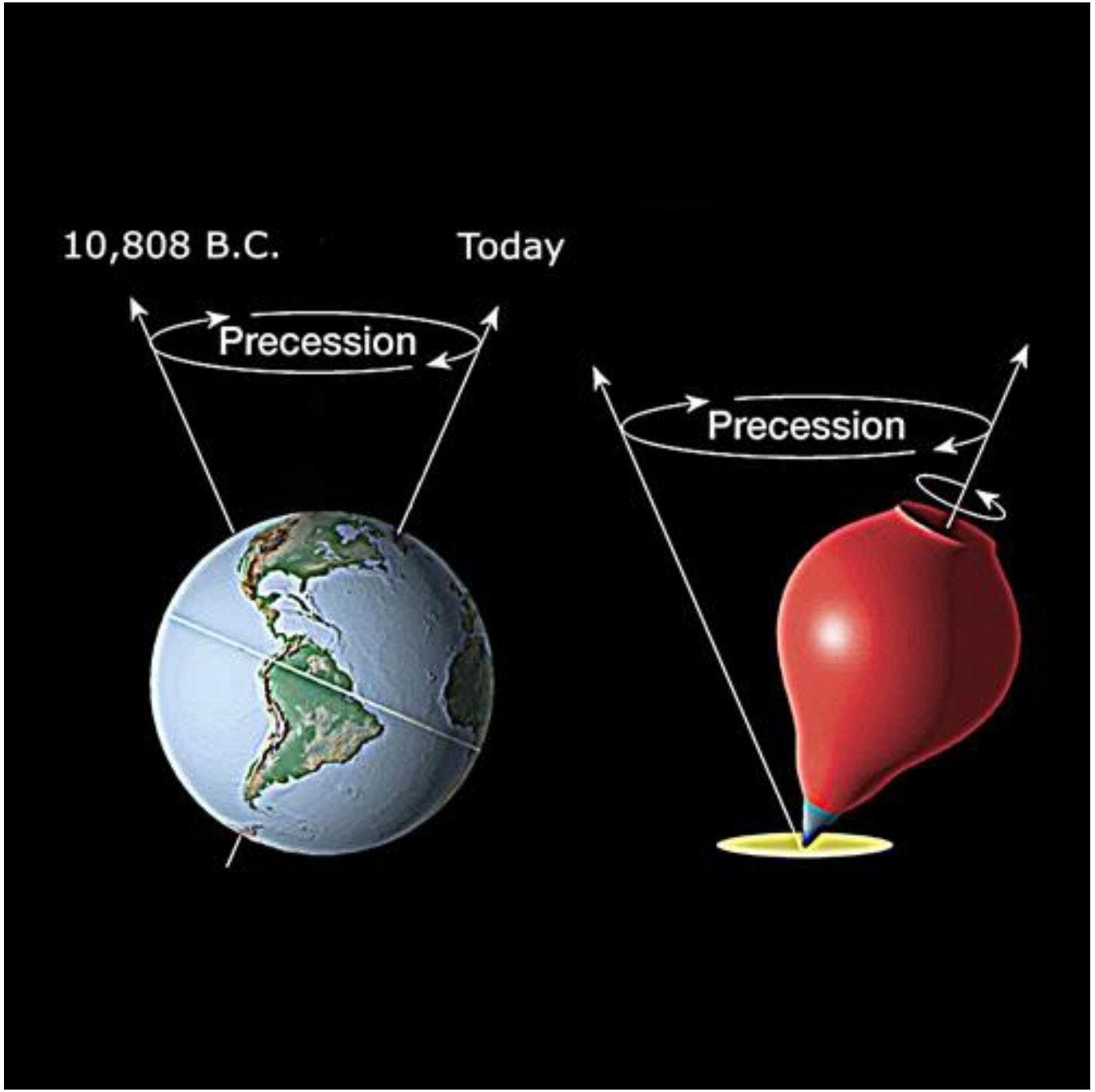

Earth
Low Tide
Moon
High Tide
Tidal Bulge
Tidal Bulge
High Tide
Low Tide

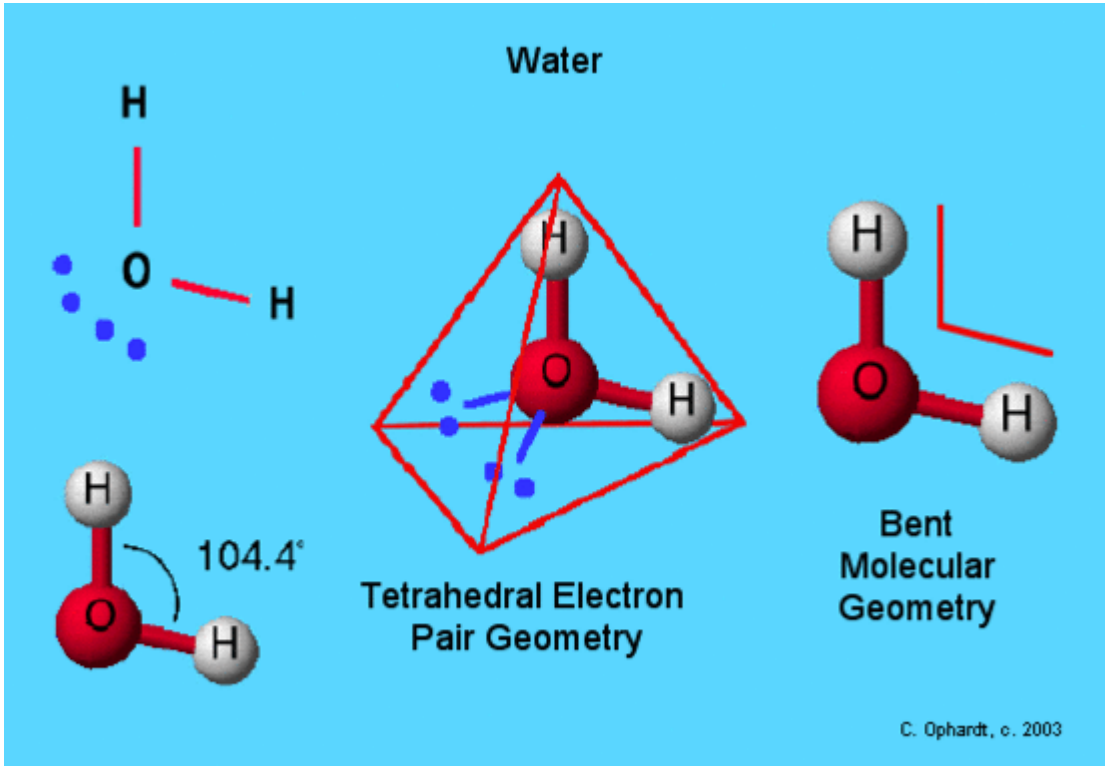


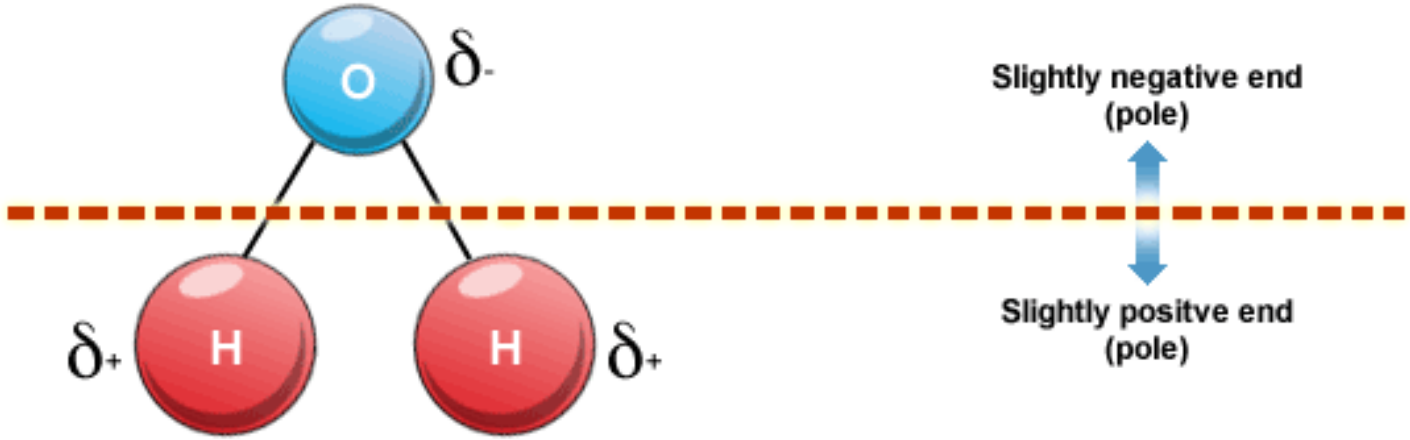
Gravitational forces from both the sun and the moon continuously pull on the Earth. Although the moon is much smaller than the sun, the moon's gravity is the dominant force behind Earth's tides.

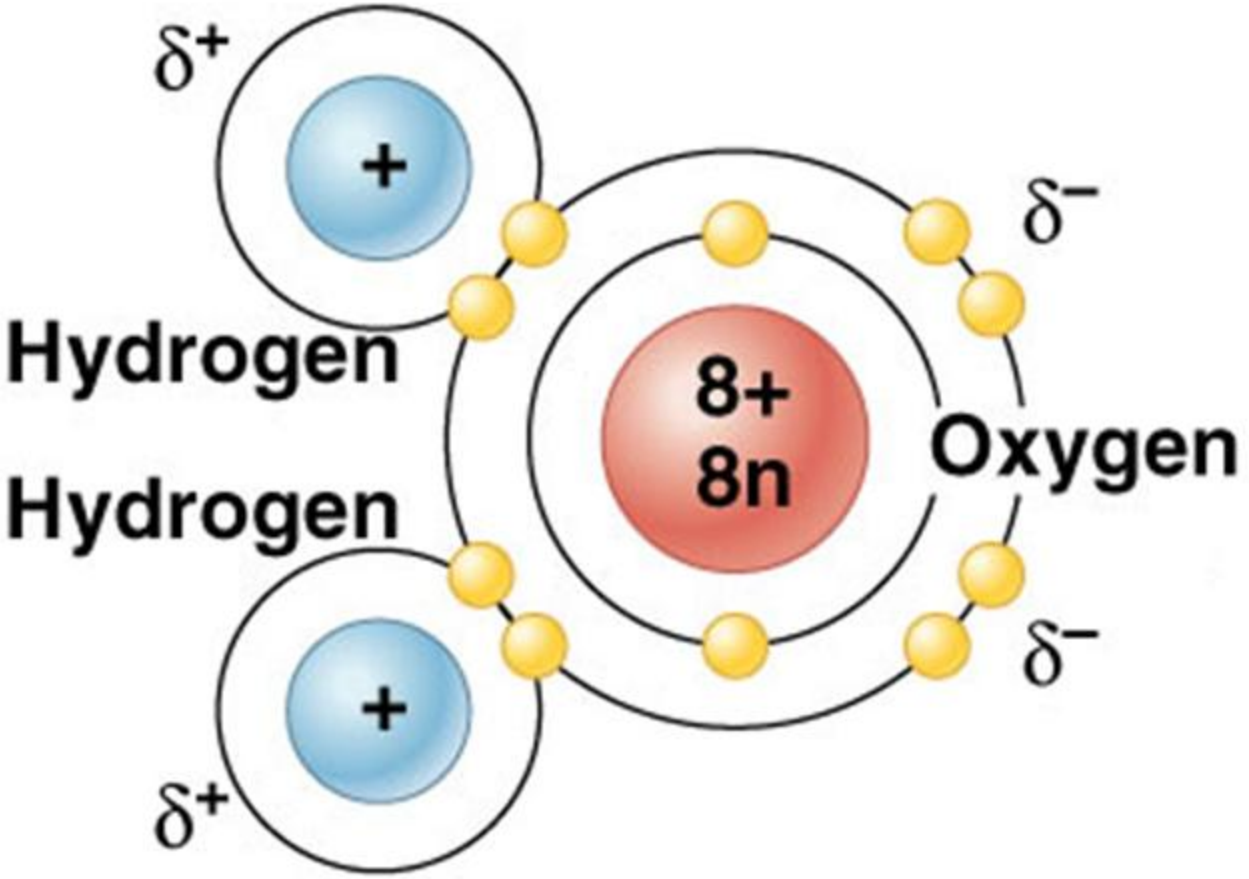
High Tide and Low Tide How high tides get and how often they occur depend on the position of the moon as it revolves around the Earth. The moon's pull is strongest on the part of the Earth directly facing the moon. When that part happens to be a part of the ocean, the water there bulges toward the moon.



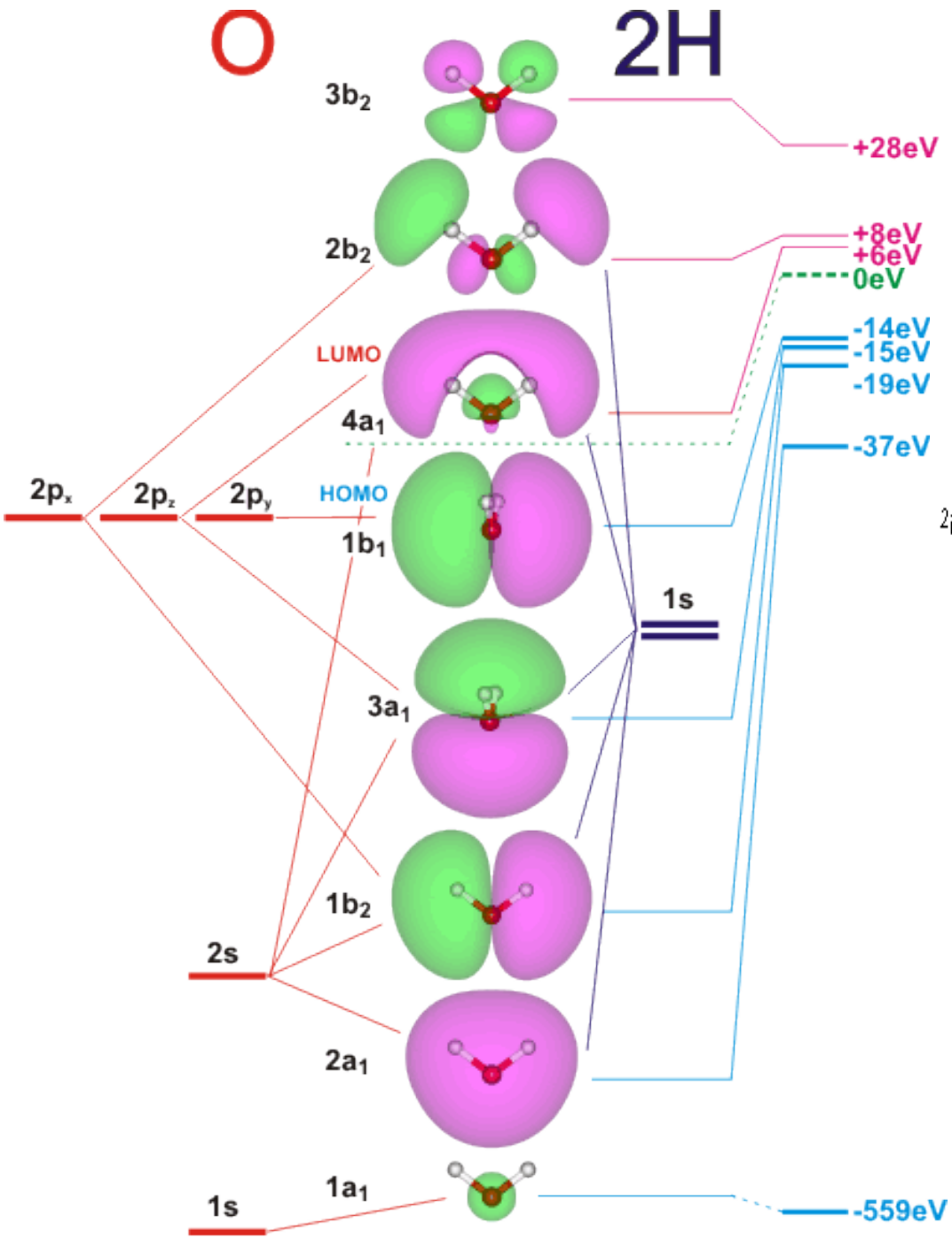

10,808 B.C.
Today
Precession
Precession

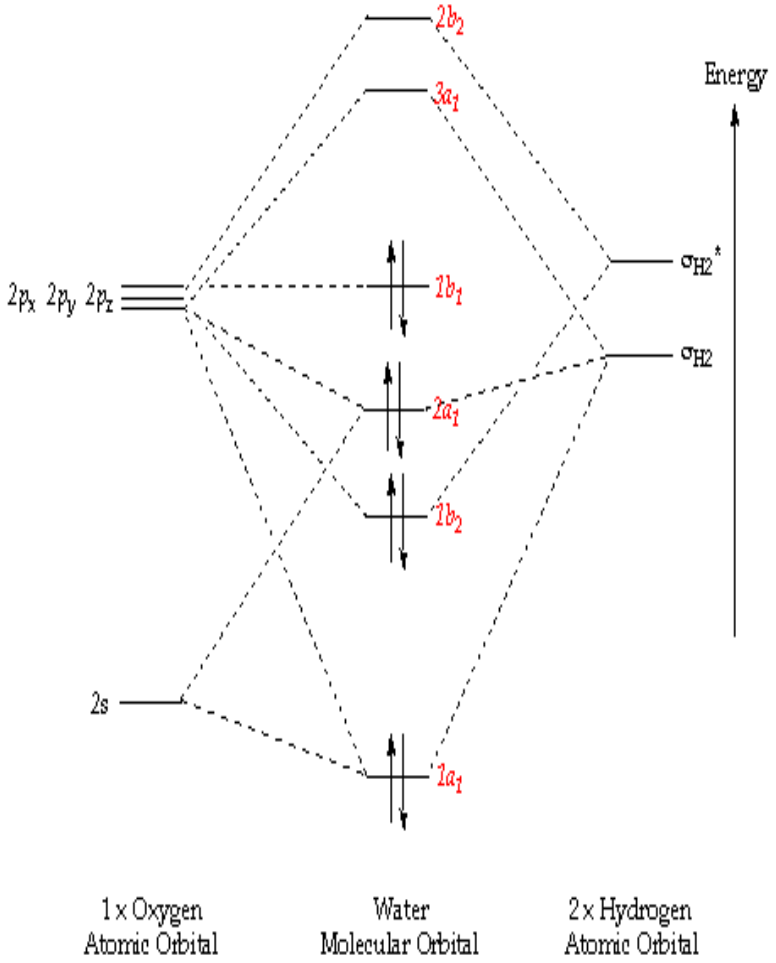

Water
H
O
H
H
O
H
104.4°
H
O
H
Tetrahedral Electron Pair Geometry
H
O
H
Bent Molecular Geometry
C. Ophardt, c. 2003

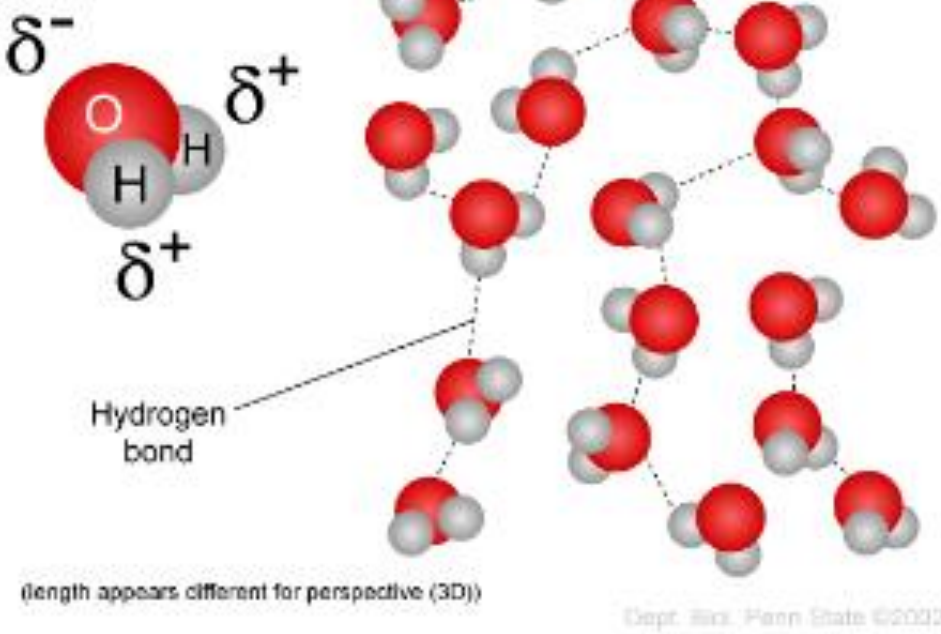

O
δ-
δ+
H
H
δ+
Slightly negative end (pole)
Slightly positve end (pole)

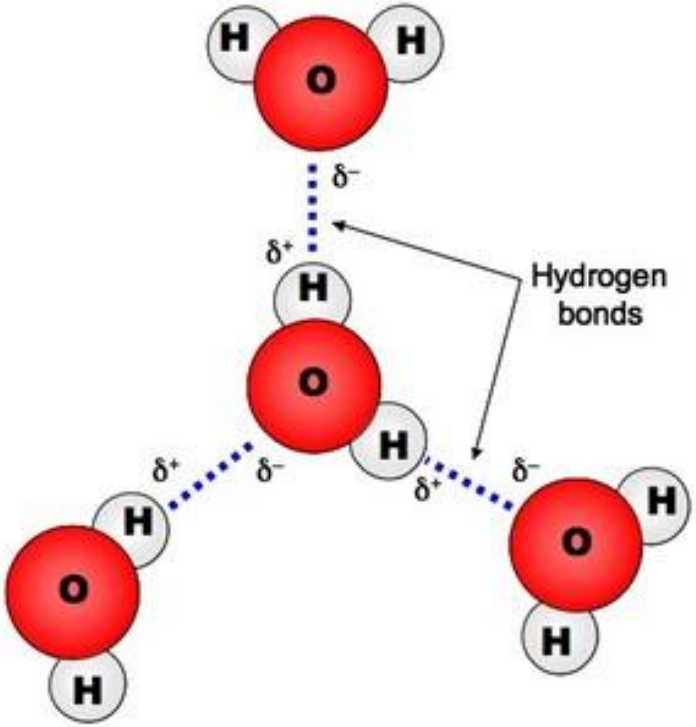


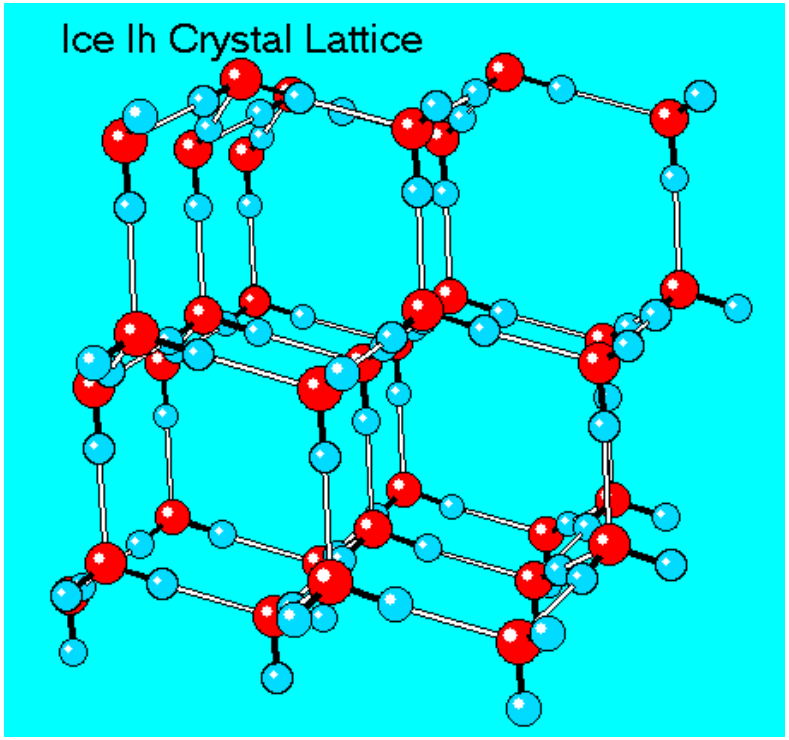
Bohr model

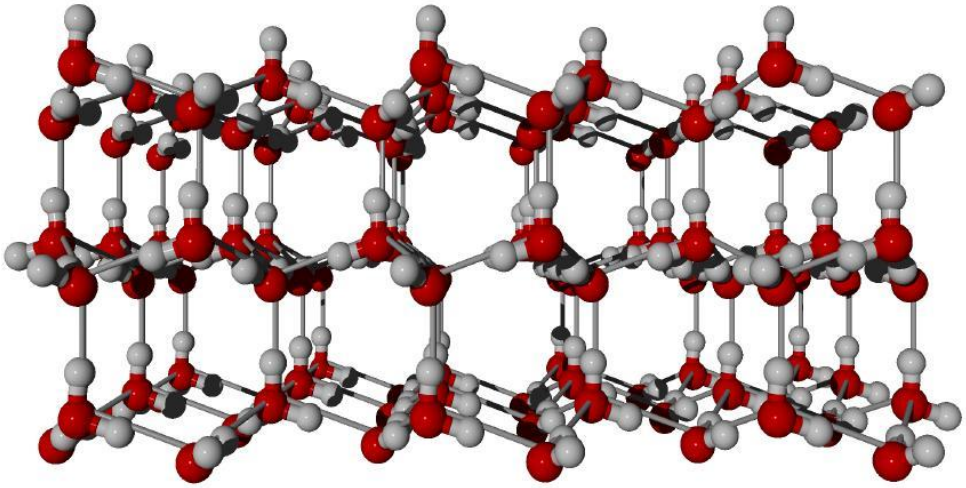

O
2H
3b2
+28eV
2b2
+8eV
+6eV
0eV
LUMO
4a1
-14eV
-15eV
-19eV
-37eV
2px
2pz
2py
HOMO
1b1
1s
3a1
1b2
2s
2a1
1a1
1s
-559eV

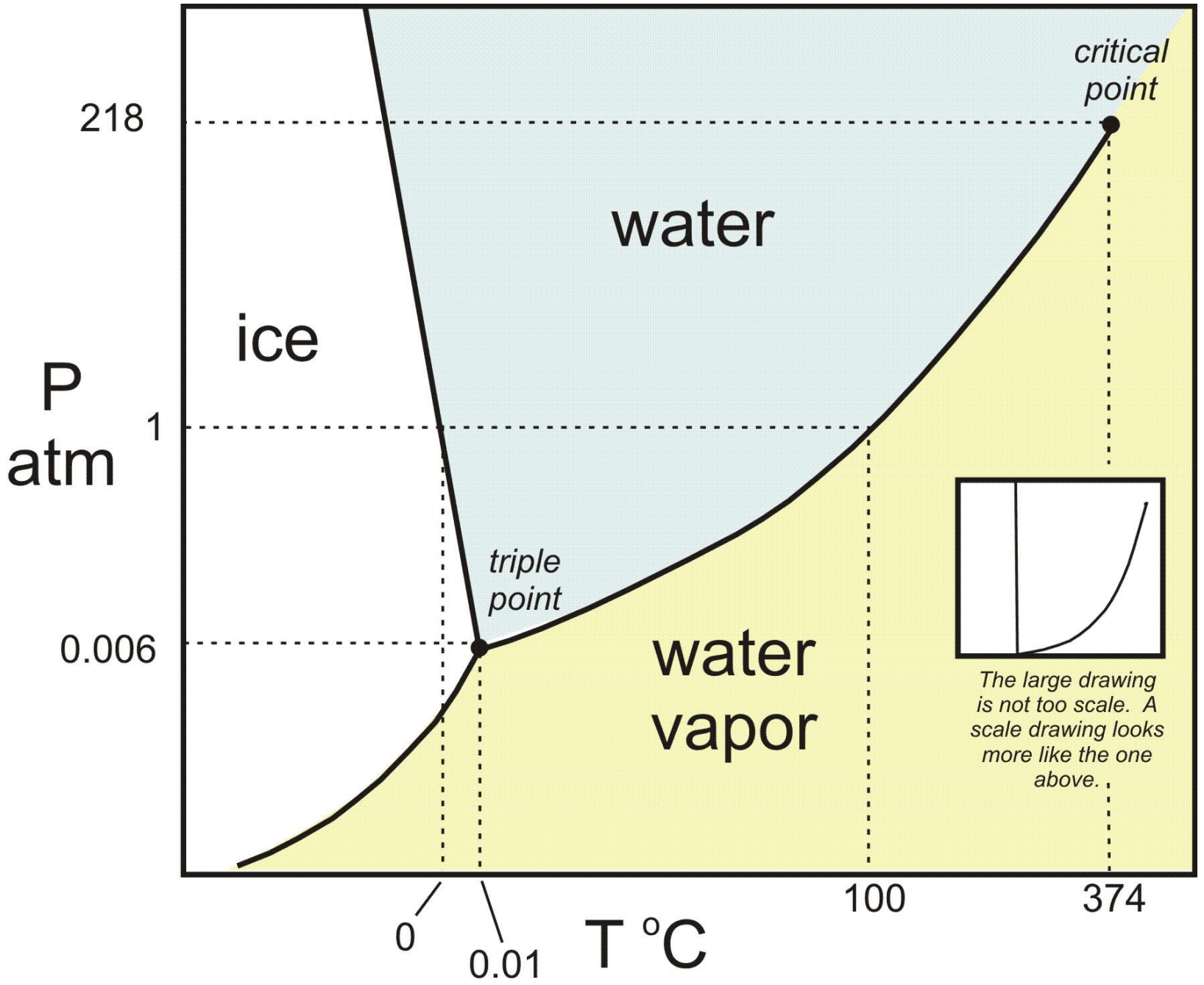

2b2
3a1
Energy
2px 2py 2pz
1b1
σH2*
σH2
2a1
1b2
2s
1a1
1 x Oxygen
Atomic Orbital
Water
Molecular Orbital
2 x Hydrogen
Atomic Orbital

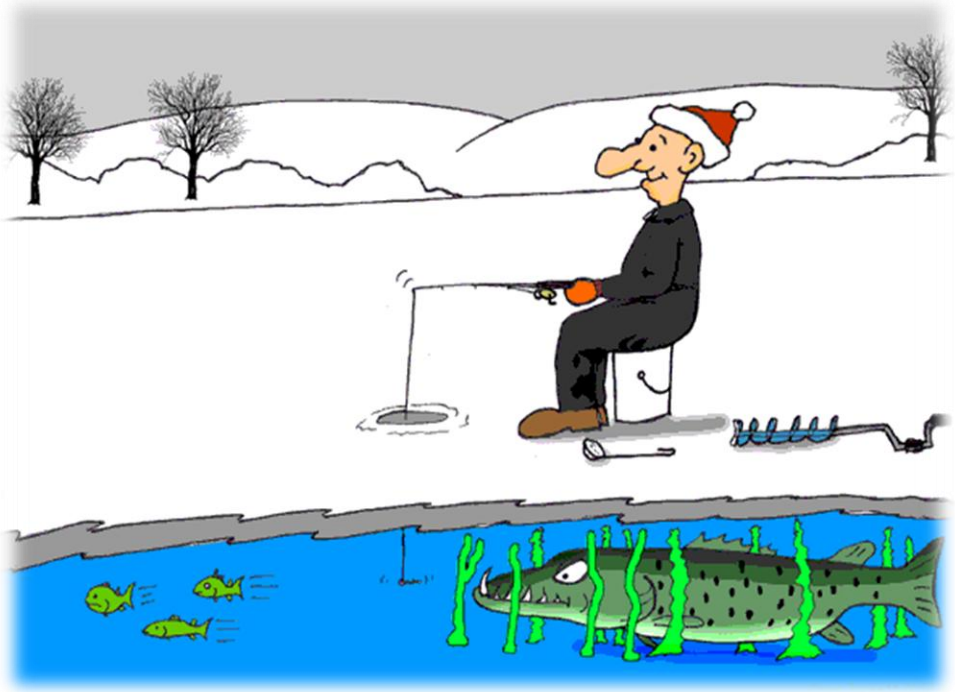


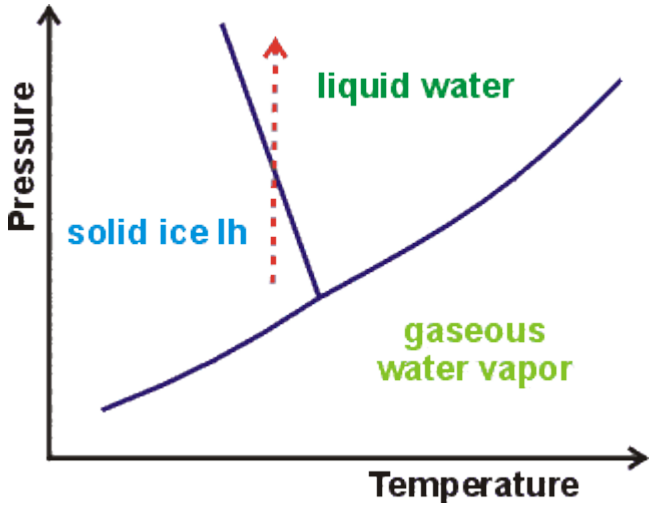


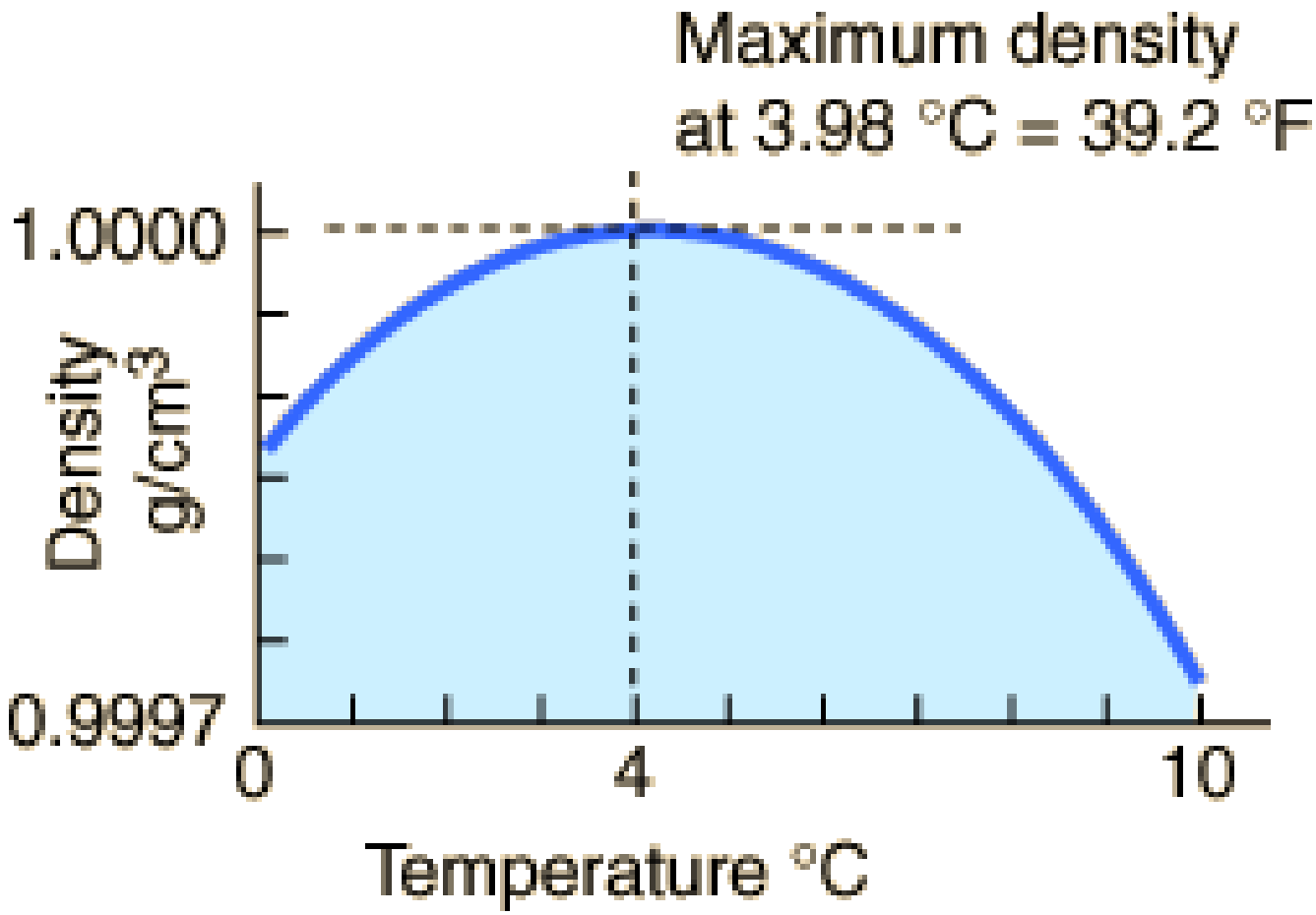

Ice Ih Crystal Lattice

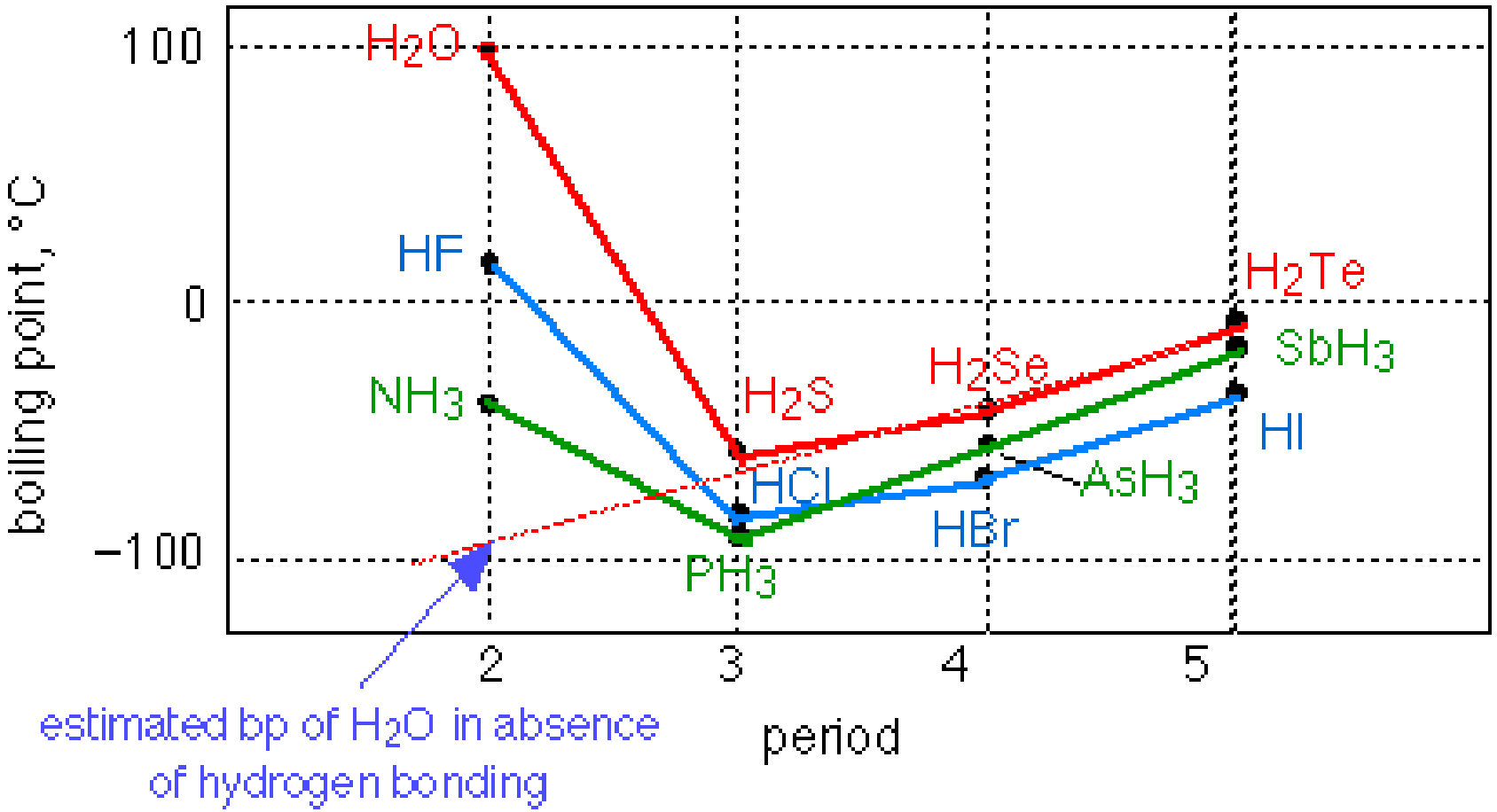


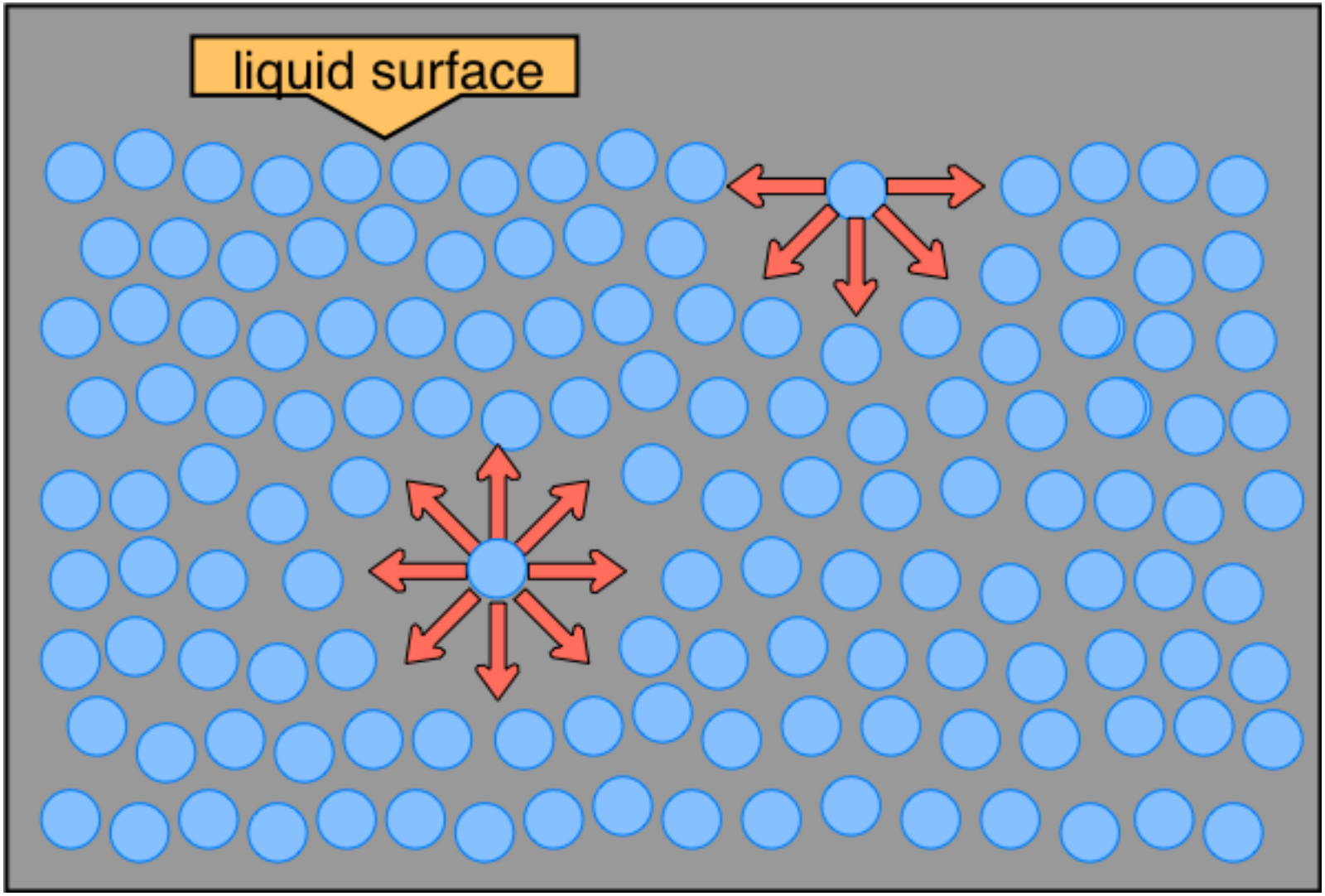

critical
point
218
water
ice
P
atm
1
triple
point
0.006
water
vapor
The large drawing
is not too scale. A
scale drawing looks
more like the one
above.
100
374
0
0.01
T °C

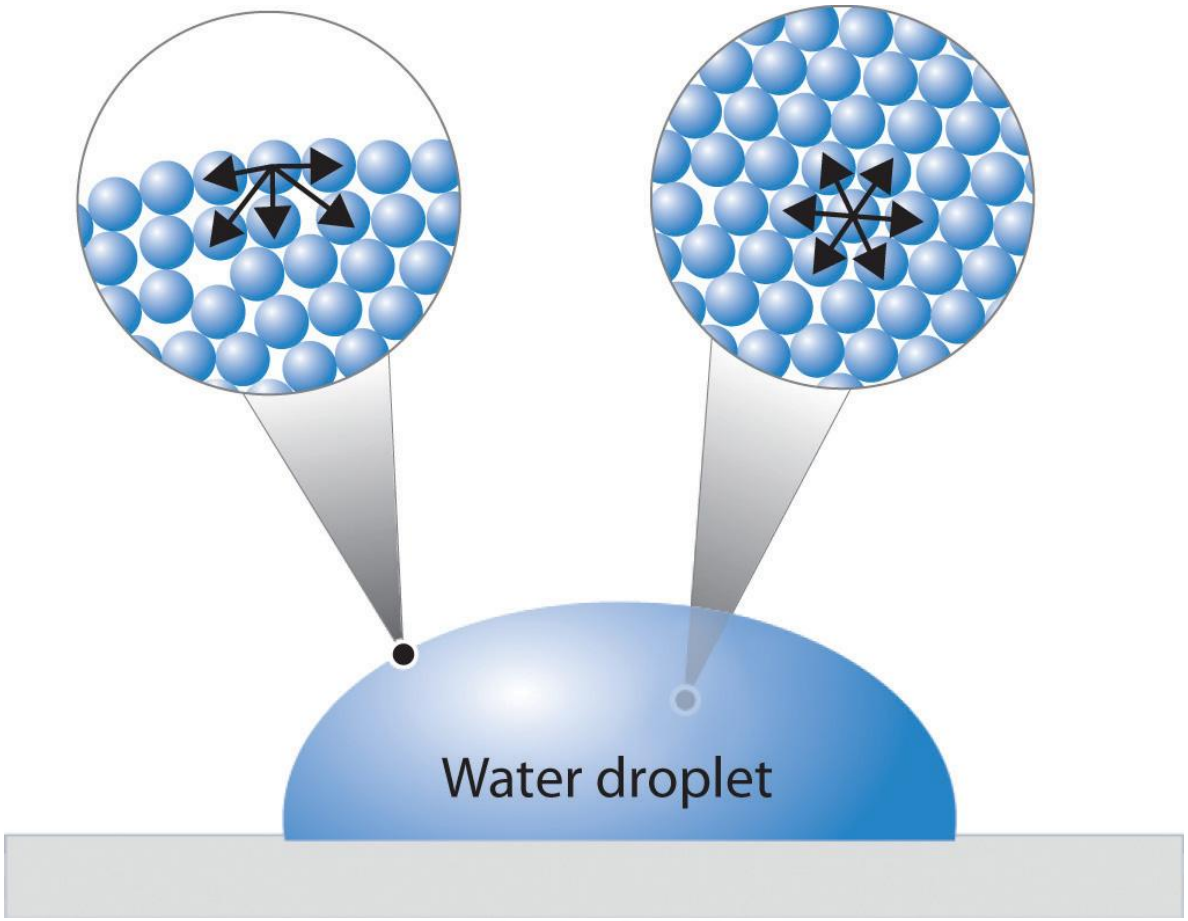


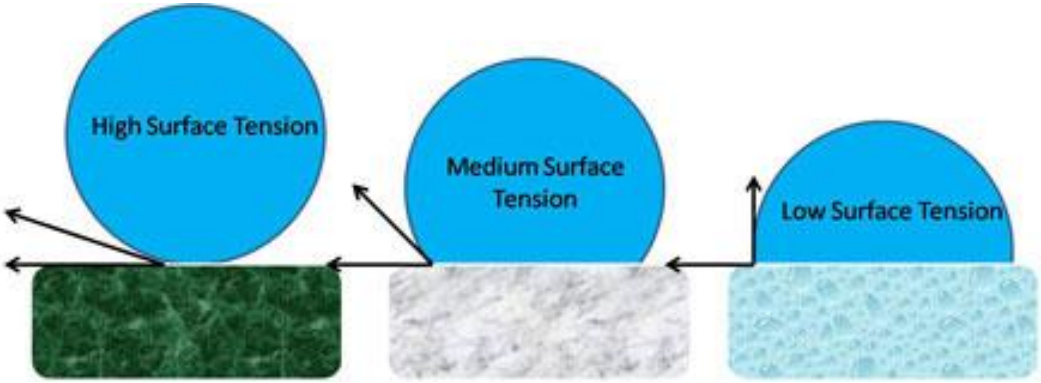

Pressure
liquid water
solid ice Ih
gaseous
water vapor
Temperature

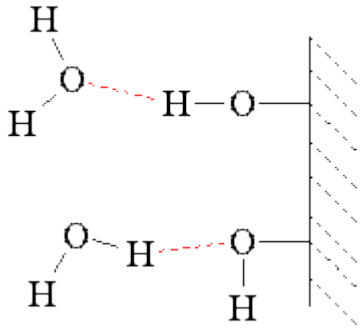

Maximum density
at 3.98 °C = 39.2 °F
1.0000
0.9997
Density
g/cm3
0
4
10
Temperature °C

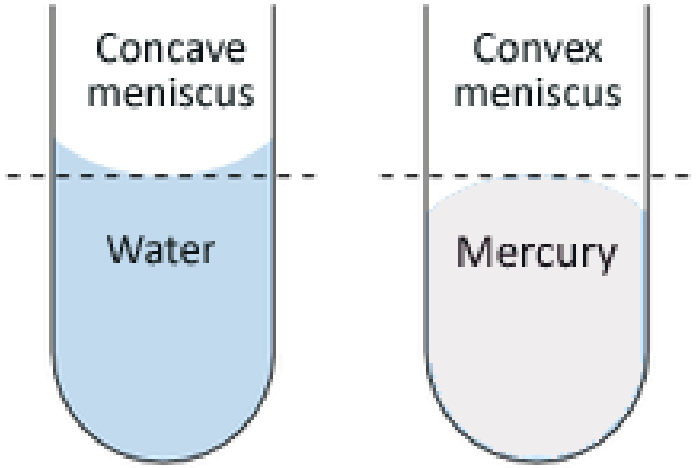

100
0
−100
boiling point, °C
2
3
4
5
period
H2O
HF
NH3
H2S
HCl
PH3
H2Se
HBr
H2Te
SbH3
HI
AsH3
estimated bp of H2O in absence
of hydrogen bonding

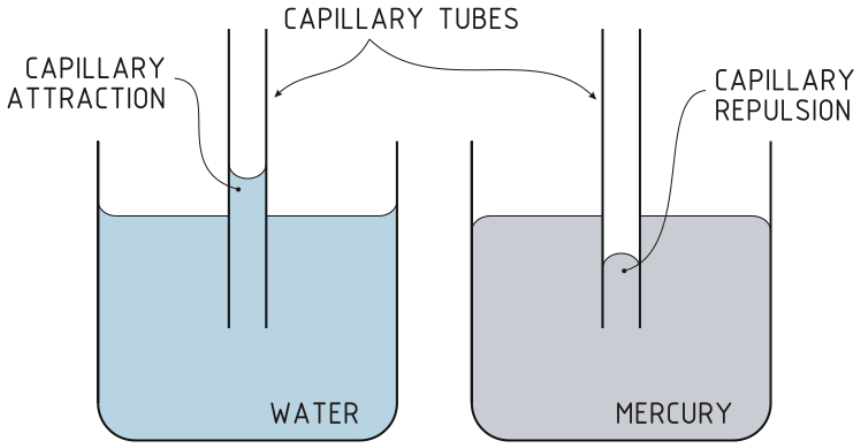

liquid surface

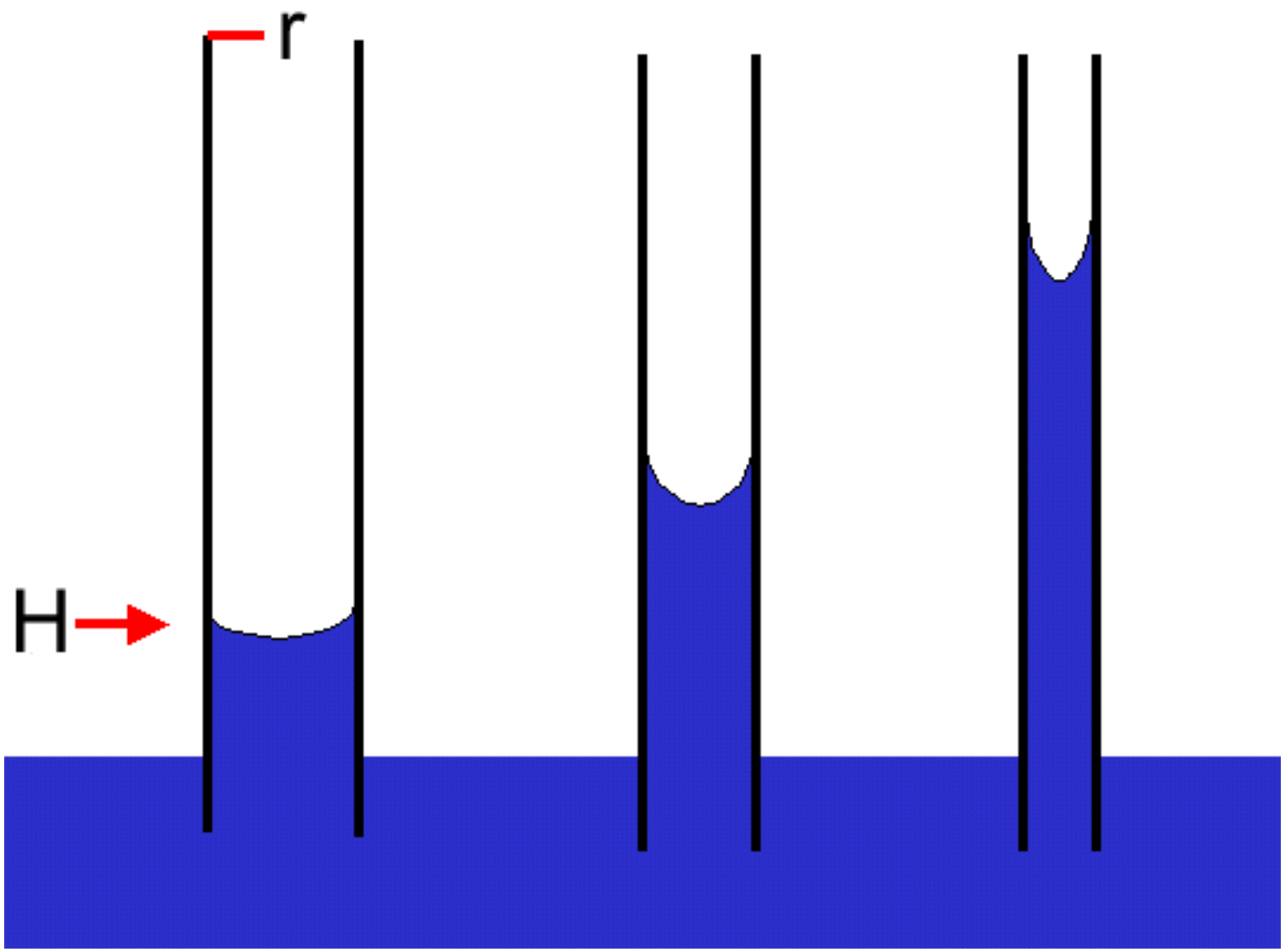

Water droplet

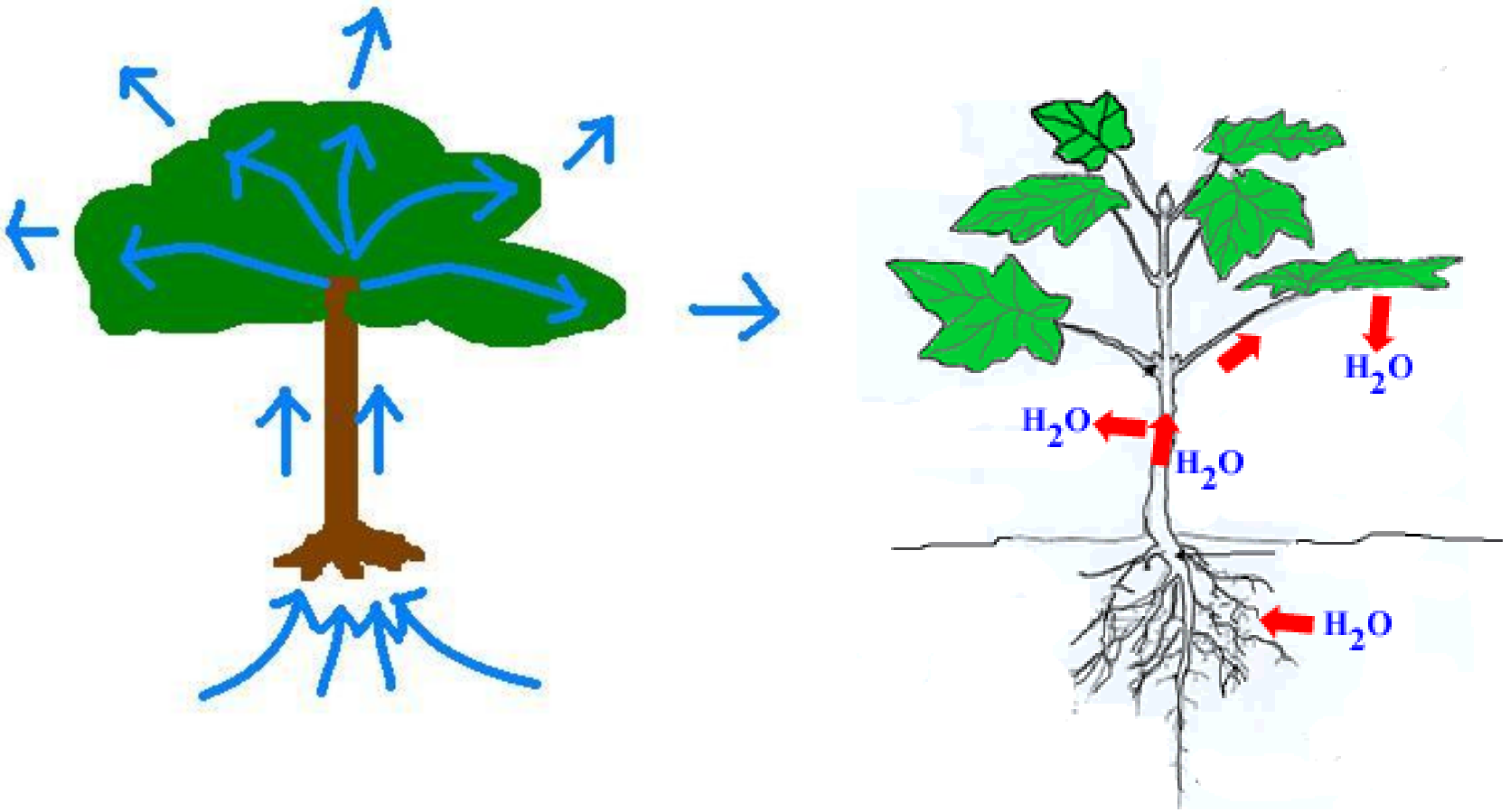

High Surface Tension
Medium Surface Tension
Low Surface Tension

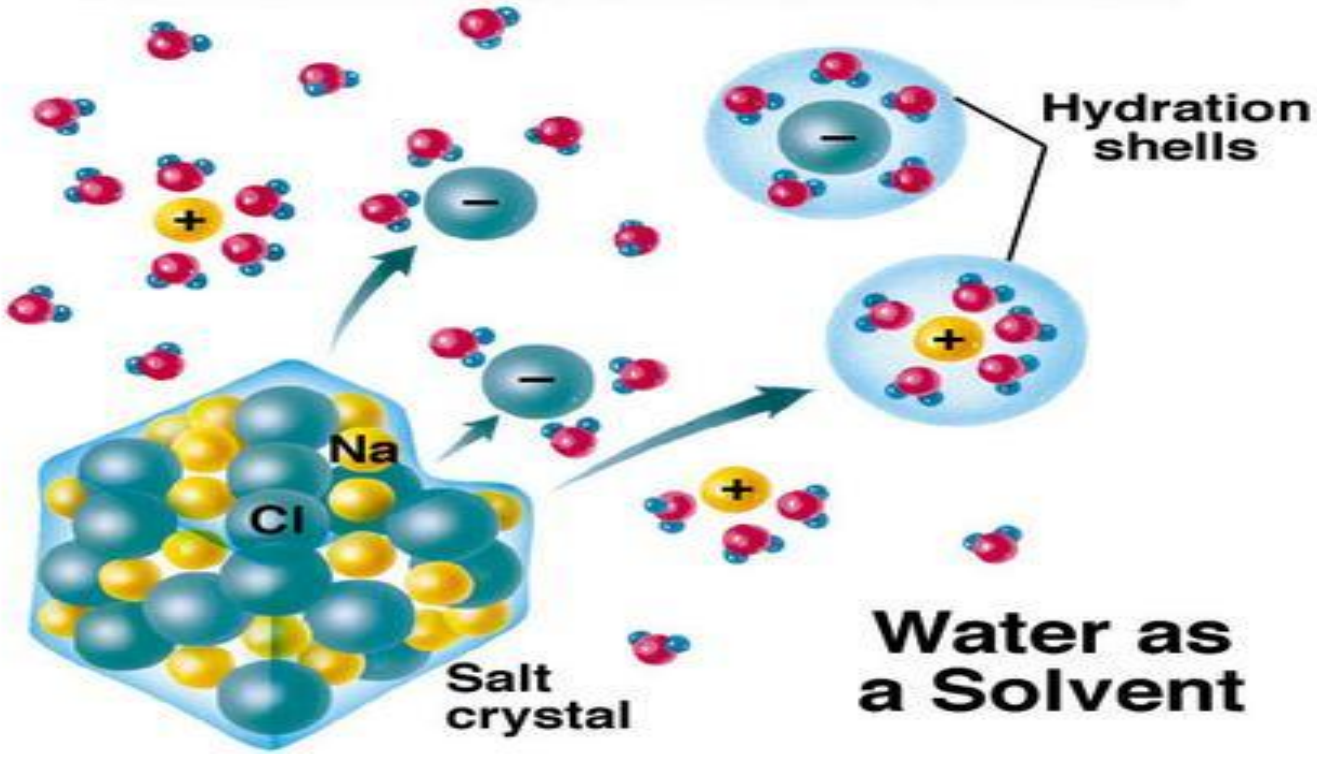

H
O
H
H
O
O
H
H
O
H

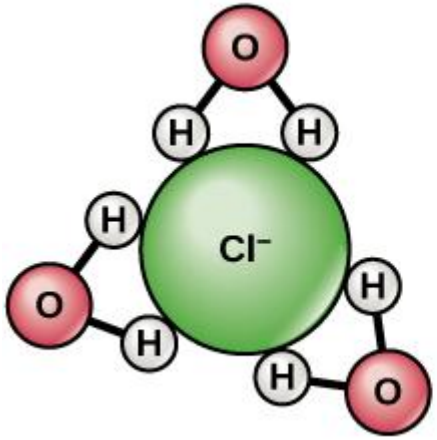

Concave meniscus
Water
Convex meniscus
Mercury

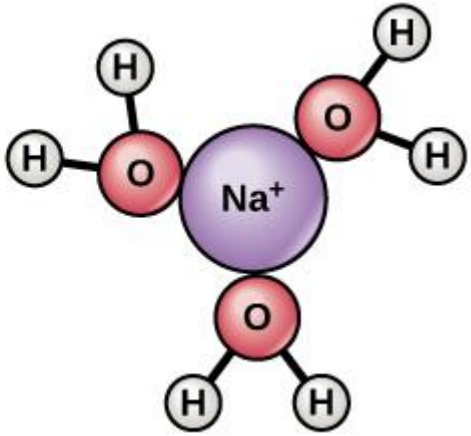

CAPILLARY TUBES
CAPILLARY ATTRACTION
CAPILLARY REPULSION
WATER
MERCURY

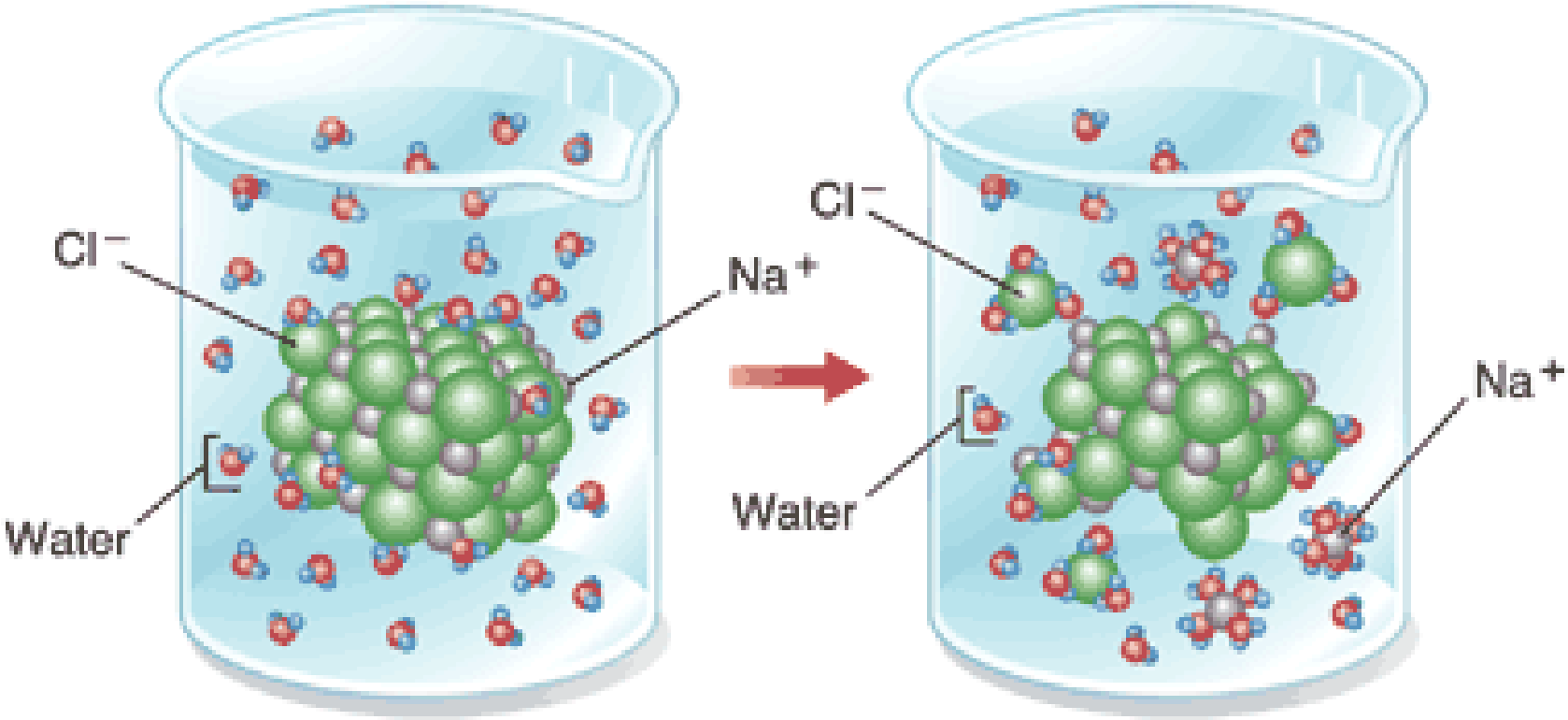

r
H


H_2O
H_2O
H_2O
H_2O

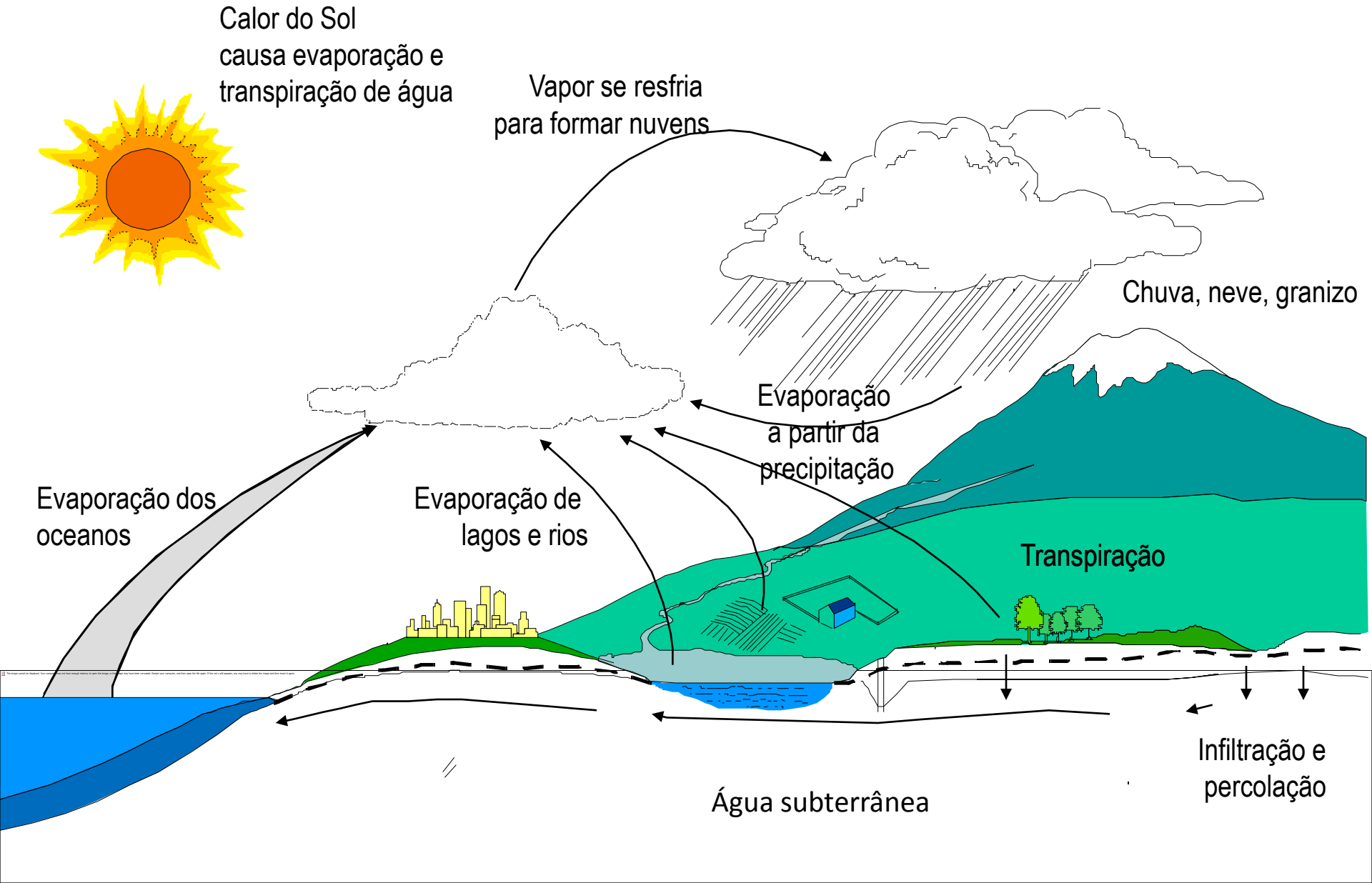


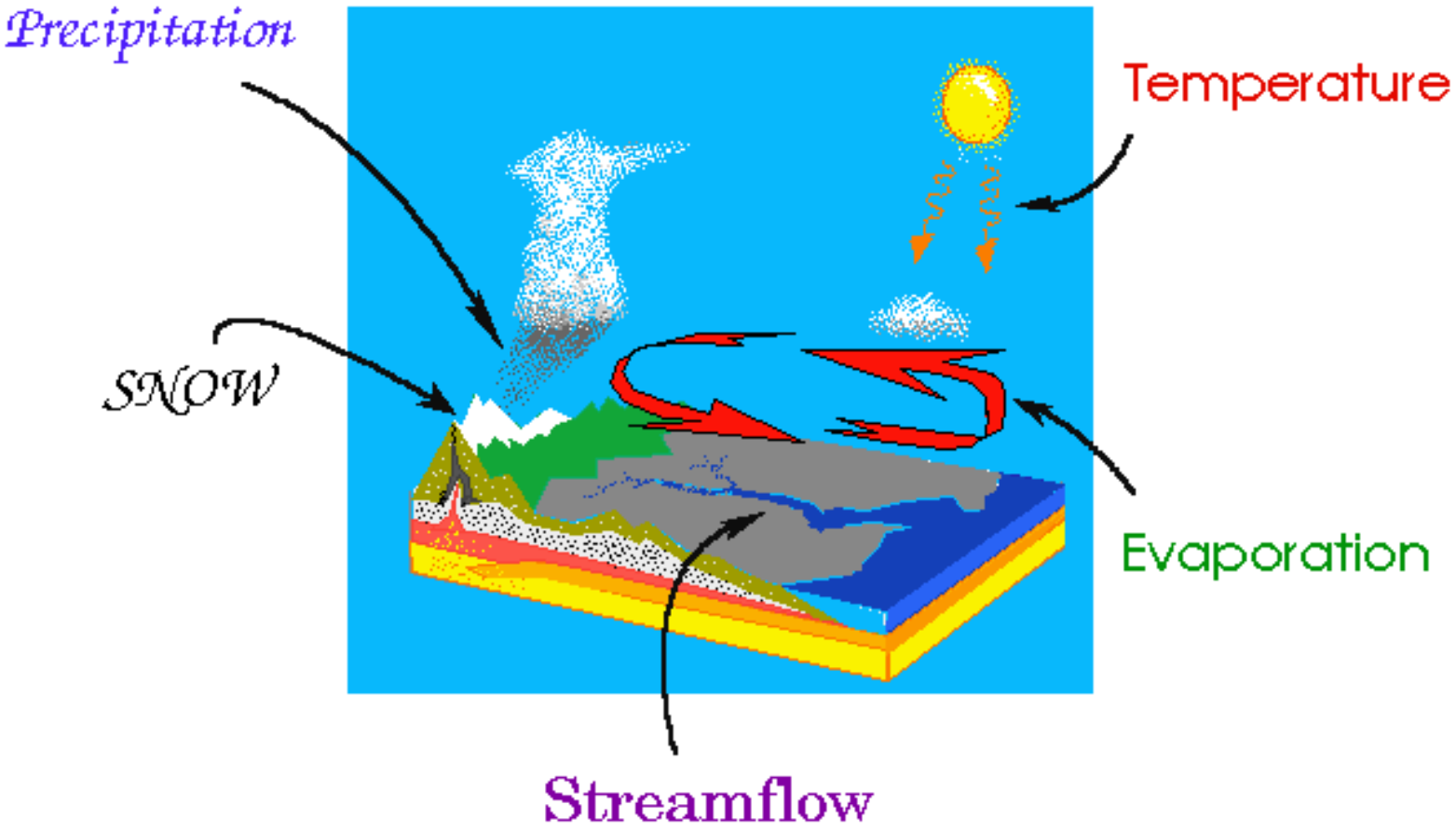




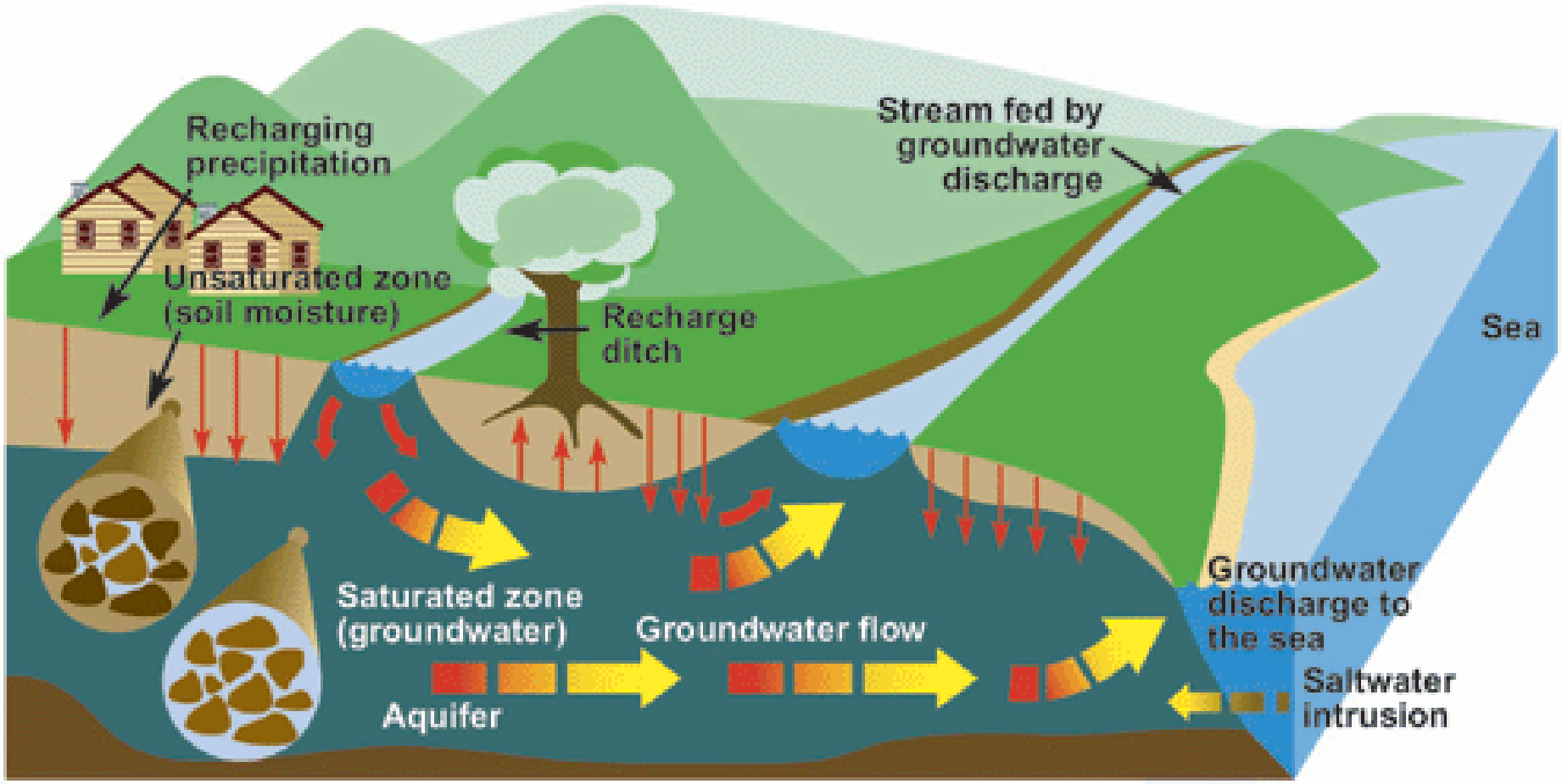

Cl⁻
Na⁺
Water
Cl⁻
Na⁺
Water

O ciclo hidrológico



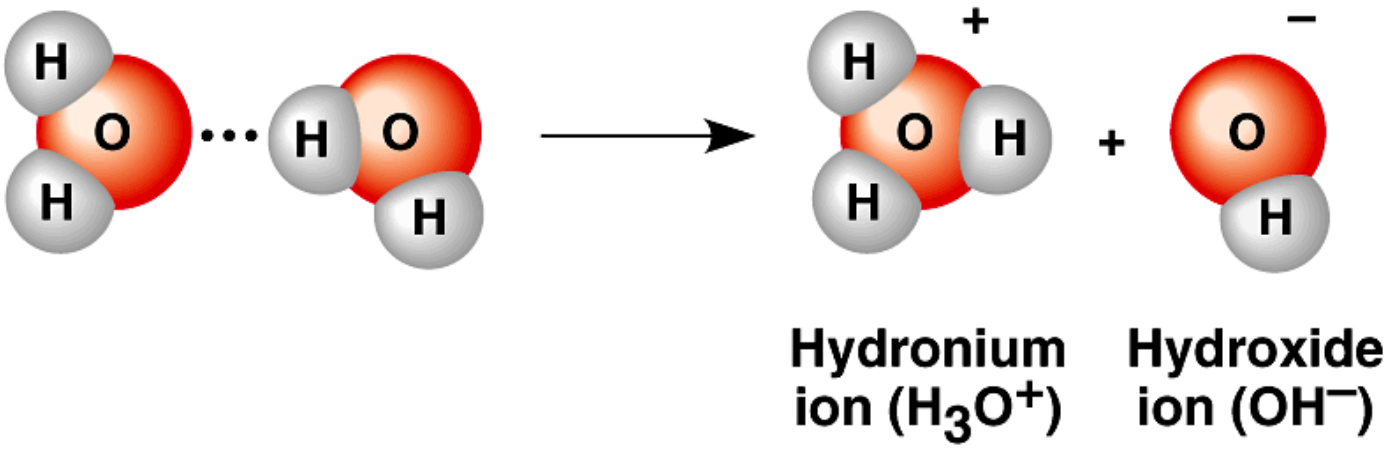

Precipitation
Temperature
SNOW
Evaporation
Streamflow

Groundwater flow



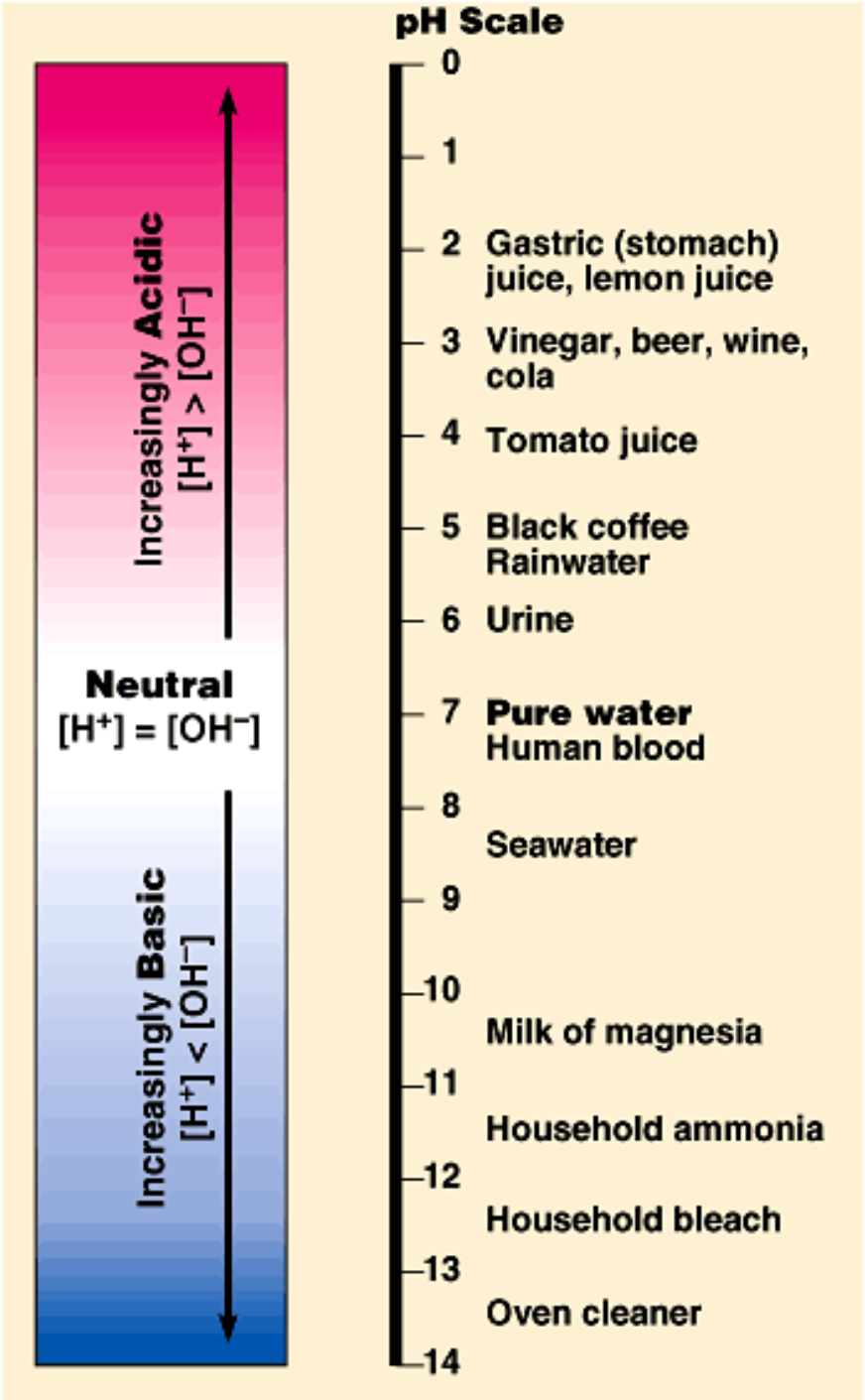
Dissociação de Moléculas de água

- Um próton – um íon de **hidrogênio** (H^+).
- A molecule de água que perde um H^+ foma uma anion **hidroxide** (OH^-).
- Cátion hidronio (H_3O^+).



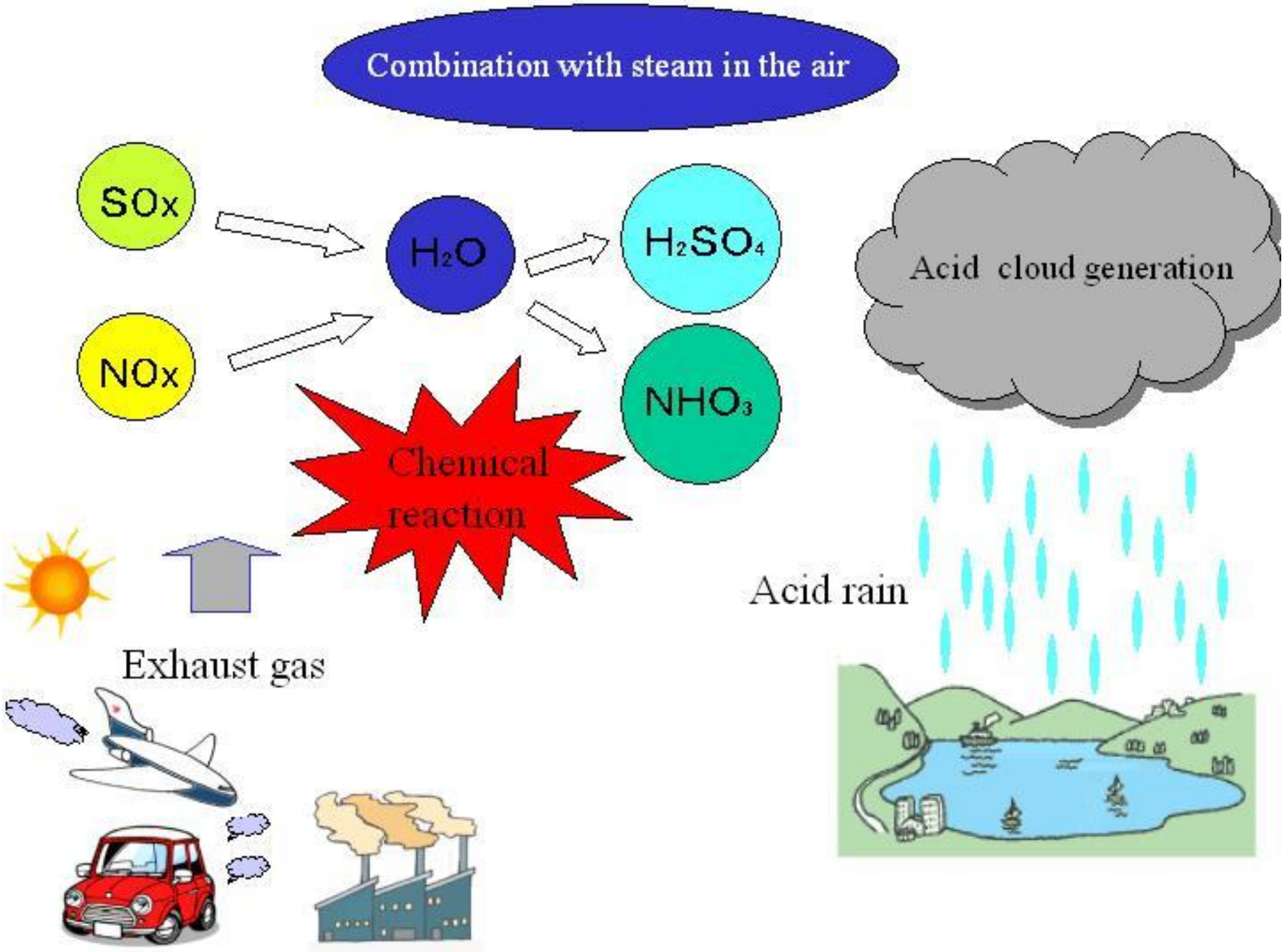
- $H_2O <=> H^+ + OH^-$

- **A reação é reversivel.**
- **No equilibrio a concentração de moléculas de água é bem superior a $[H_3O]^+$ e OH^-.**
- **Em água pura somente uma molecule em cada 554 milhões está dissociada.**
  - **No equilibrium, a $[H_3O]^+$ ou OH^- é de 10^{-7}M (25°C) .**


pH Scale
Increasingly Acidic
[H+] > [OH−]
Neutral
[H+] = [OH−]
Increasingly Basic
[H+] < [OH−]
0
1
2 Gastric (stomach) juice, lemon juice
3 Vinegar, beer, wine, cola
4 Tomato juice
5 Black coffee Rainwater
6 Urine
7 Pure water Human blood
8 Seawater
9
10 Milk of magnesia
11 Household ammonia
12 Household bleach
13 Oven cleaner
14

Chuva Ácida

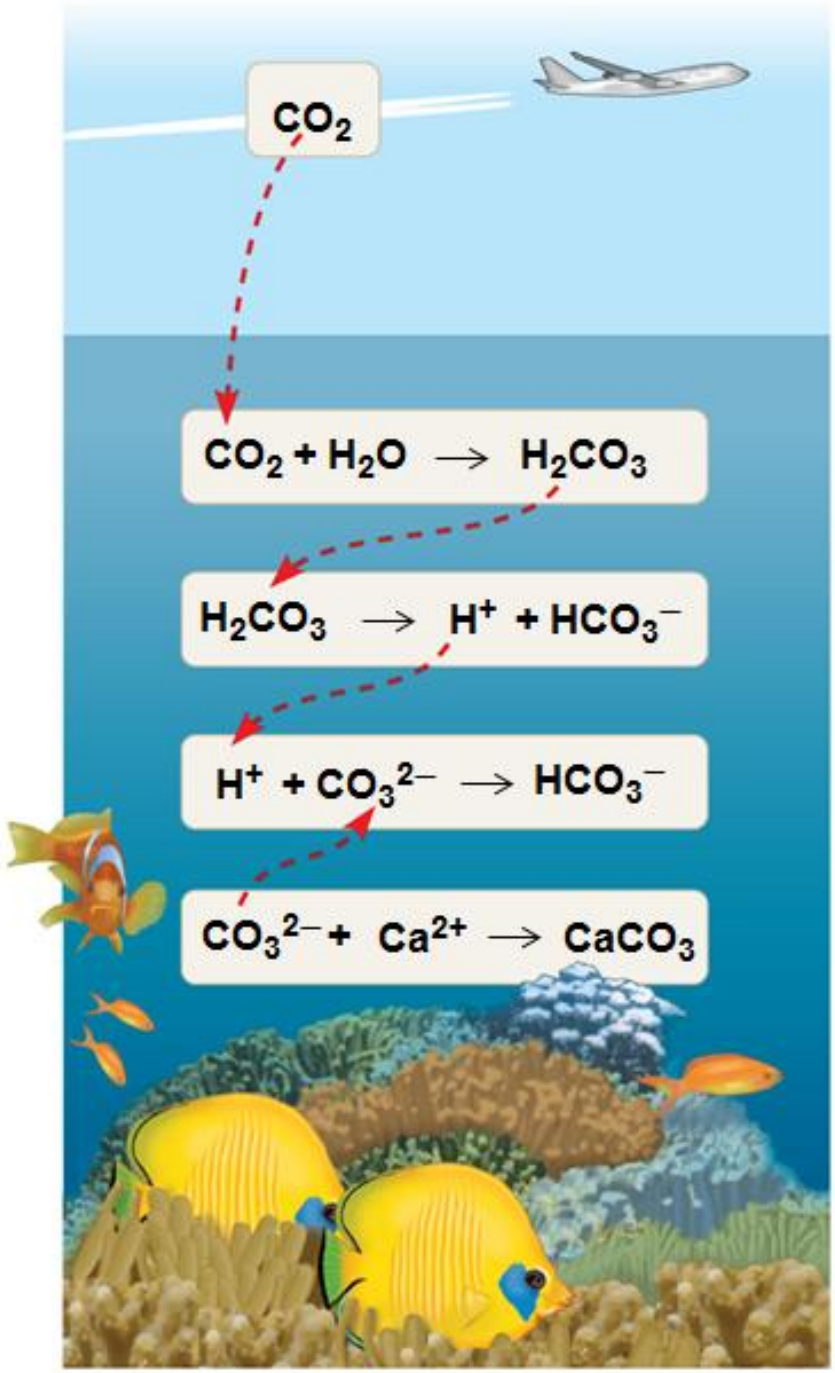
- chuva, neve ou neblina pH < 5.6
- pH 1.5
- SOx e NOx reagem com água na atmosfera
  - **Diminui pH do solo afetando a solubilidade de minerais – prejuízos para as florestas**
  - **Diminiu pH of lagos – Lagos com pH <5 sem peixes.**


Combination with steam in the air
SOx
NOx
H2O
H2SO4
NHO3
Chemical reaction
Acid cloud generation
Acid rain
Exhaust gas

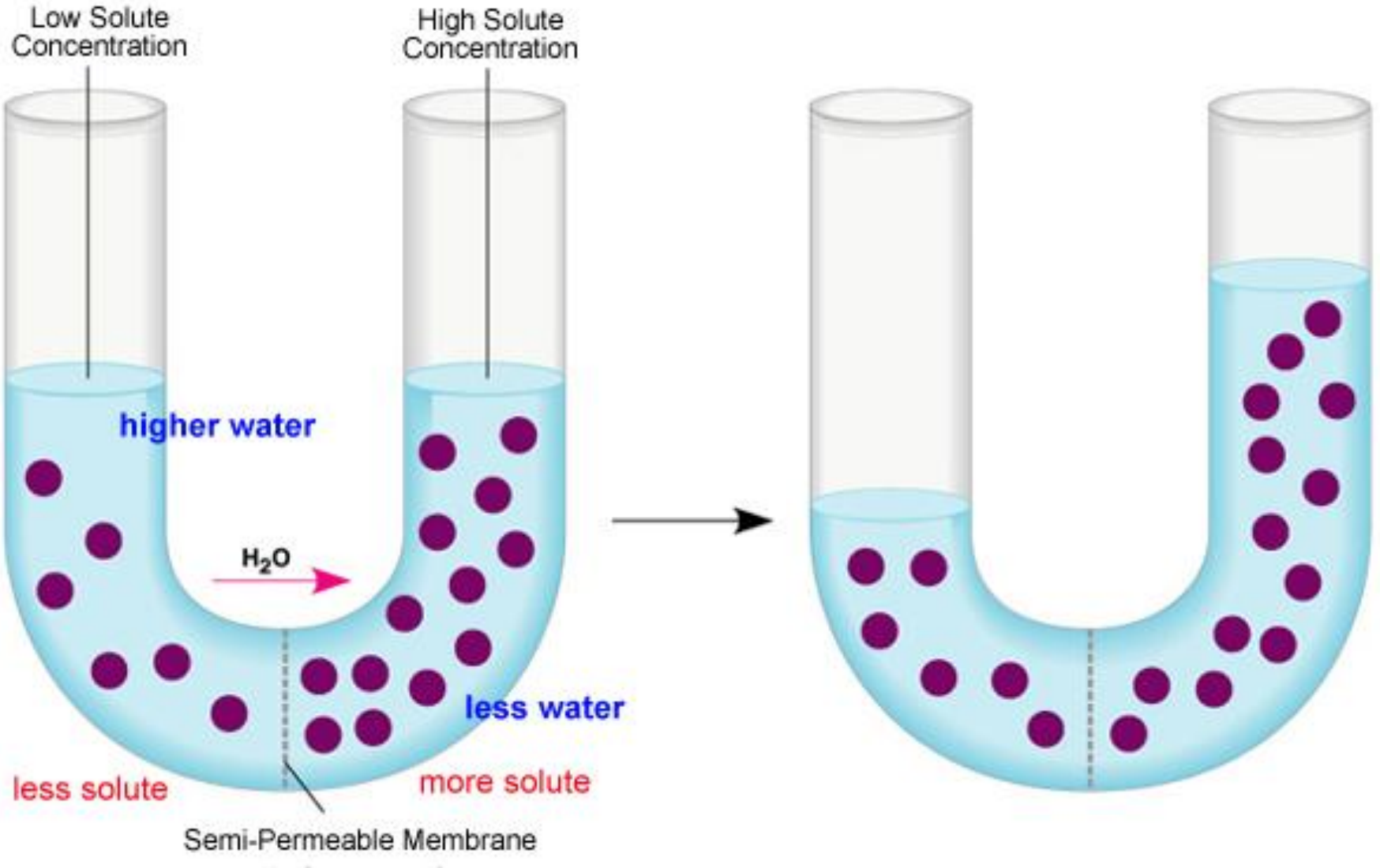
CO_2 – Combustão de combustíveis fósseis

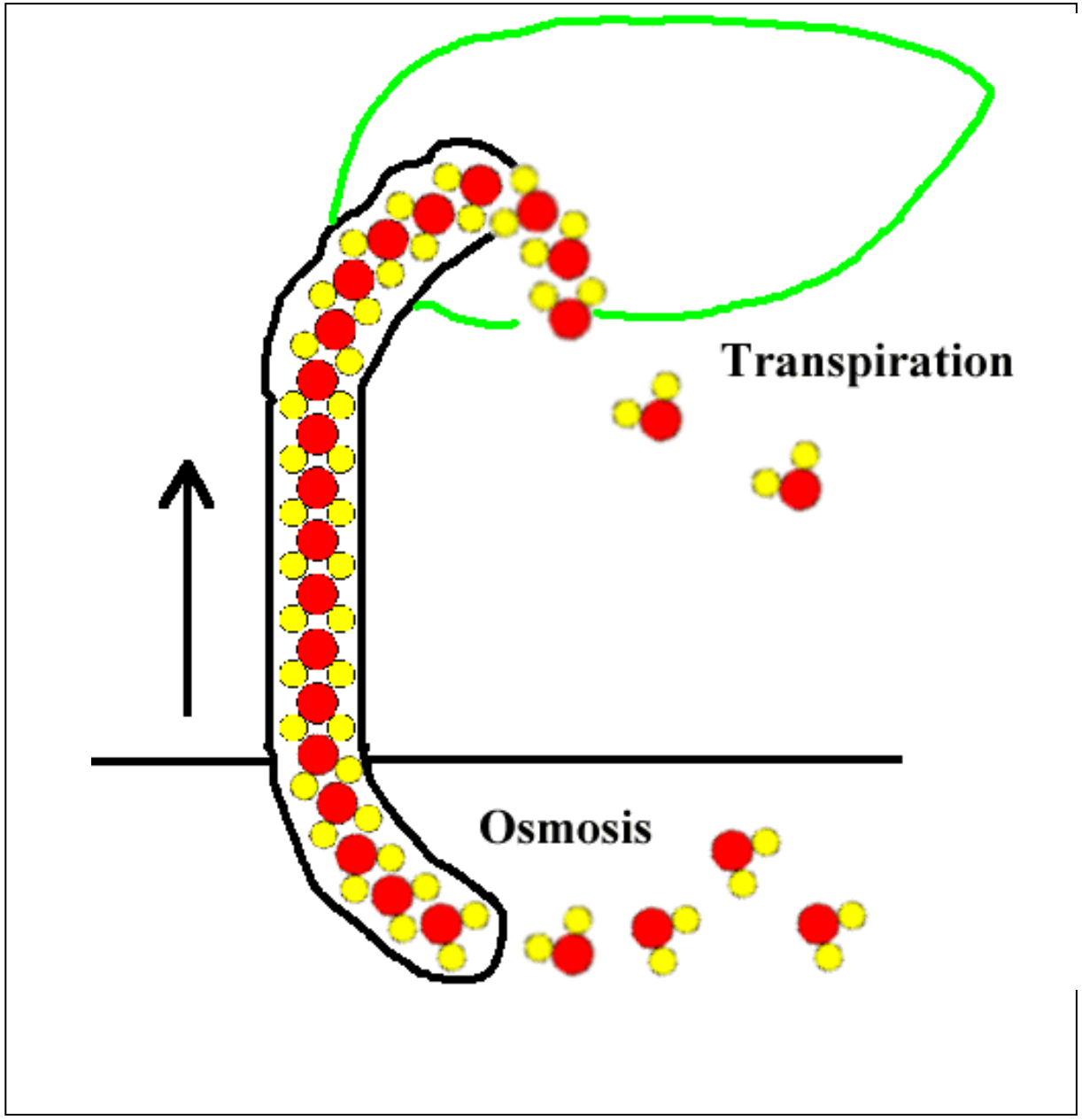
25% of CO_2 absorvido pelos oceanos

CO_2 dissolvido na água do mar forma **ácido carbônico = oceanos ácidos**



Osmosis


Low Solute Concentration
High Solute Concentration
higher water
H_2O
less water
less solute
more solute
Semi-Permeable Membrane


Transpiration
Osmosis

Transpiration—Cohesion Hypothesis

Evaporation (the driving force)

The lower water potential of air causes evaporation from cell walls.

This lowers the water potential in cell walls and in cytoplasm.

Cohesion (in xylem)

Cohesion holds water columns together in capillary-sized xylem elements.

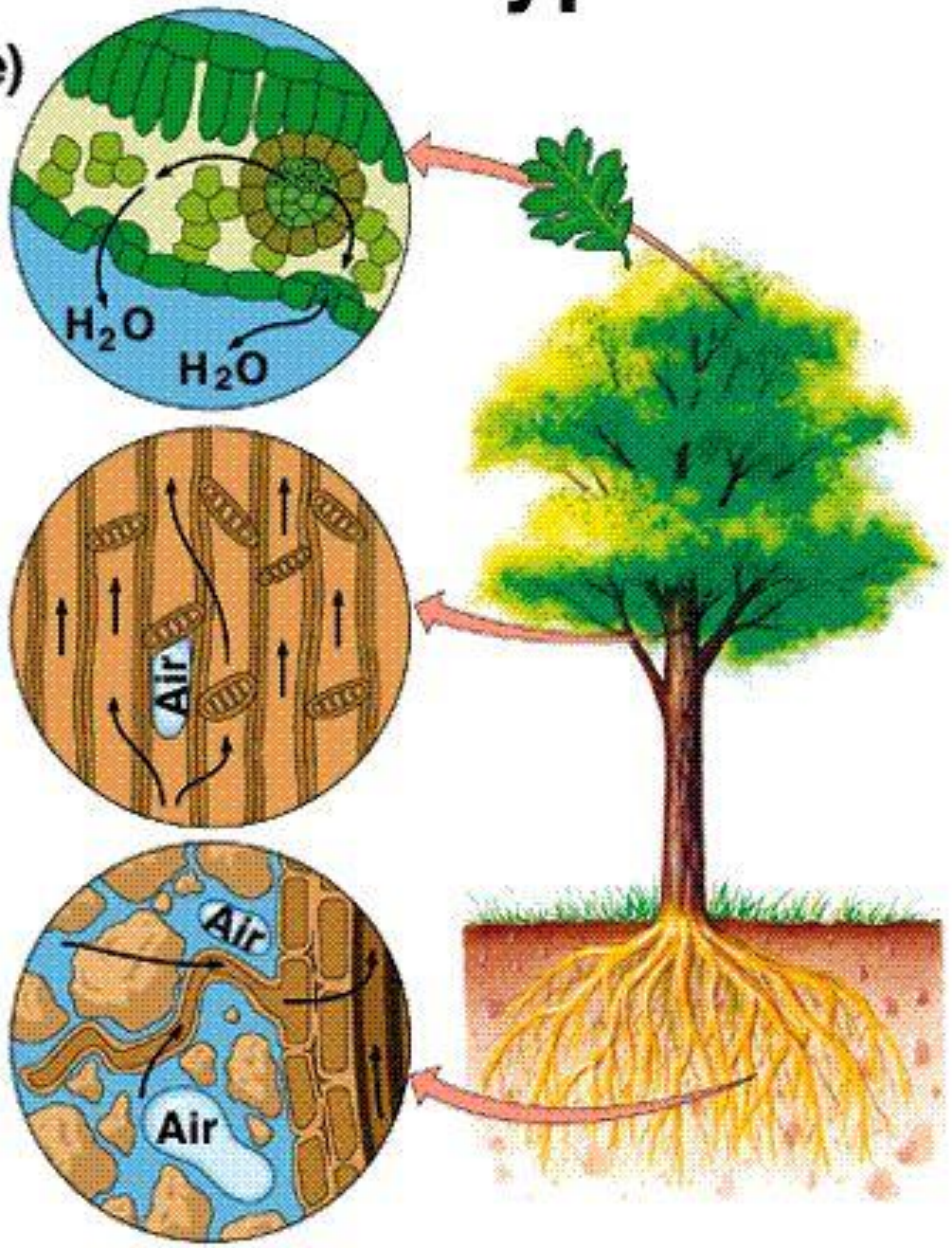
Air bubbles block movement of water to next element.

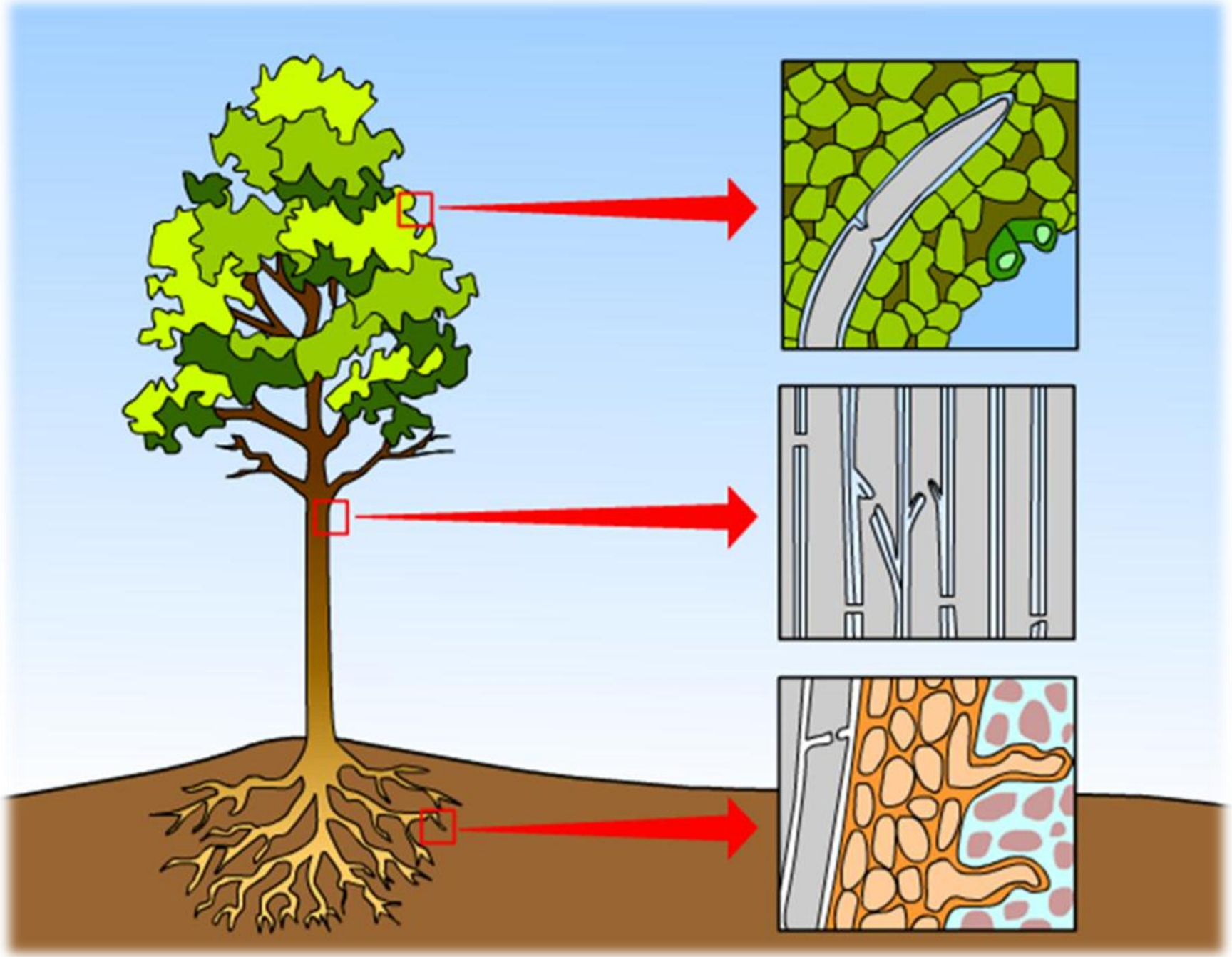
Water uptake (from soil)

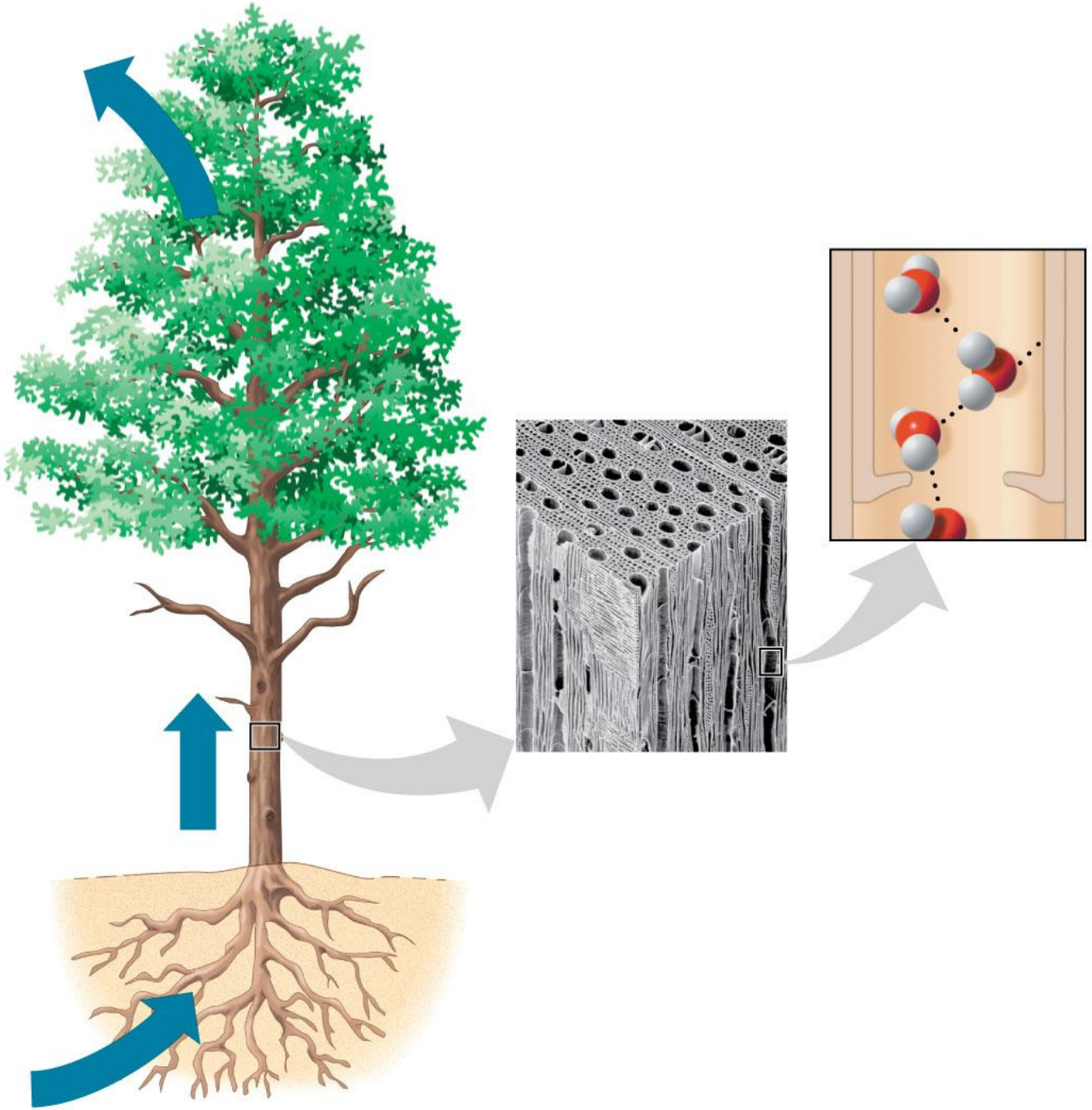
Lower water potential in root cells draws water from soil.

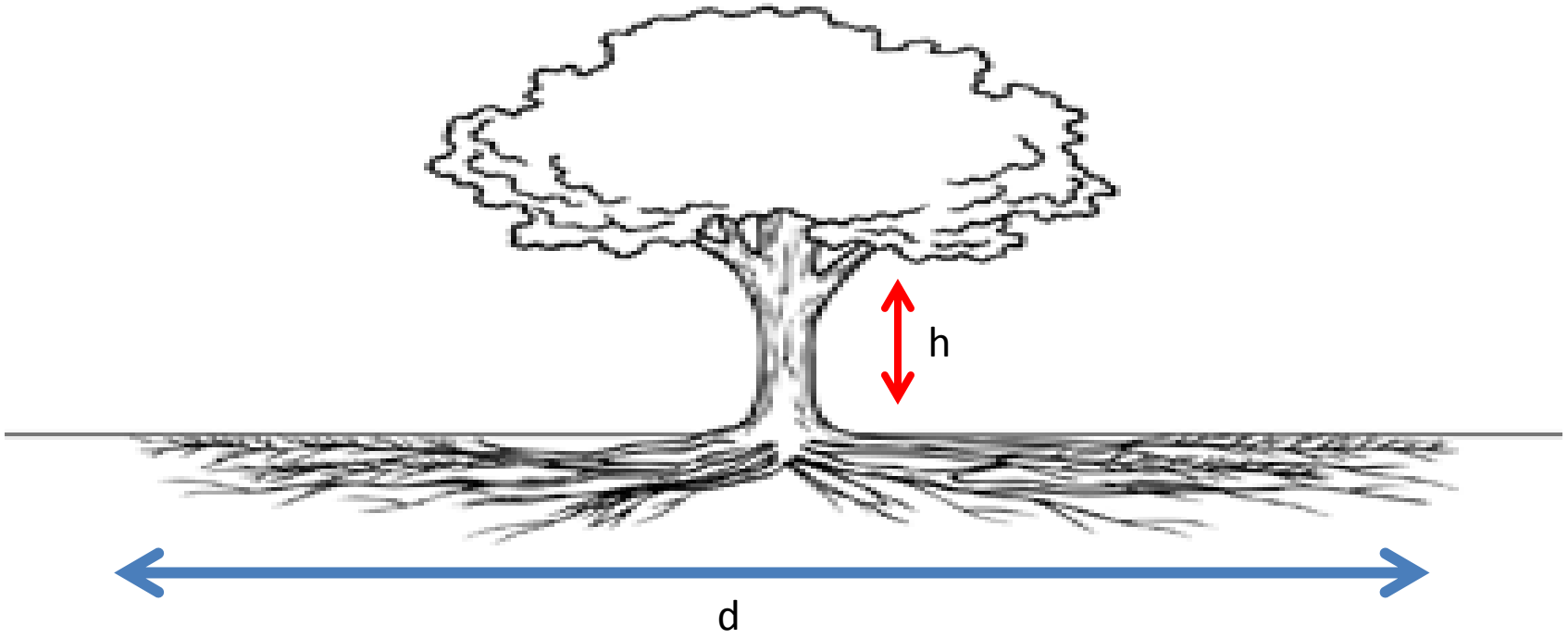
The absorptive surface increases with the production of more root hairs.

Water moves through endodermis by osmosis.

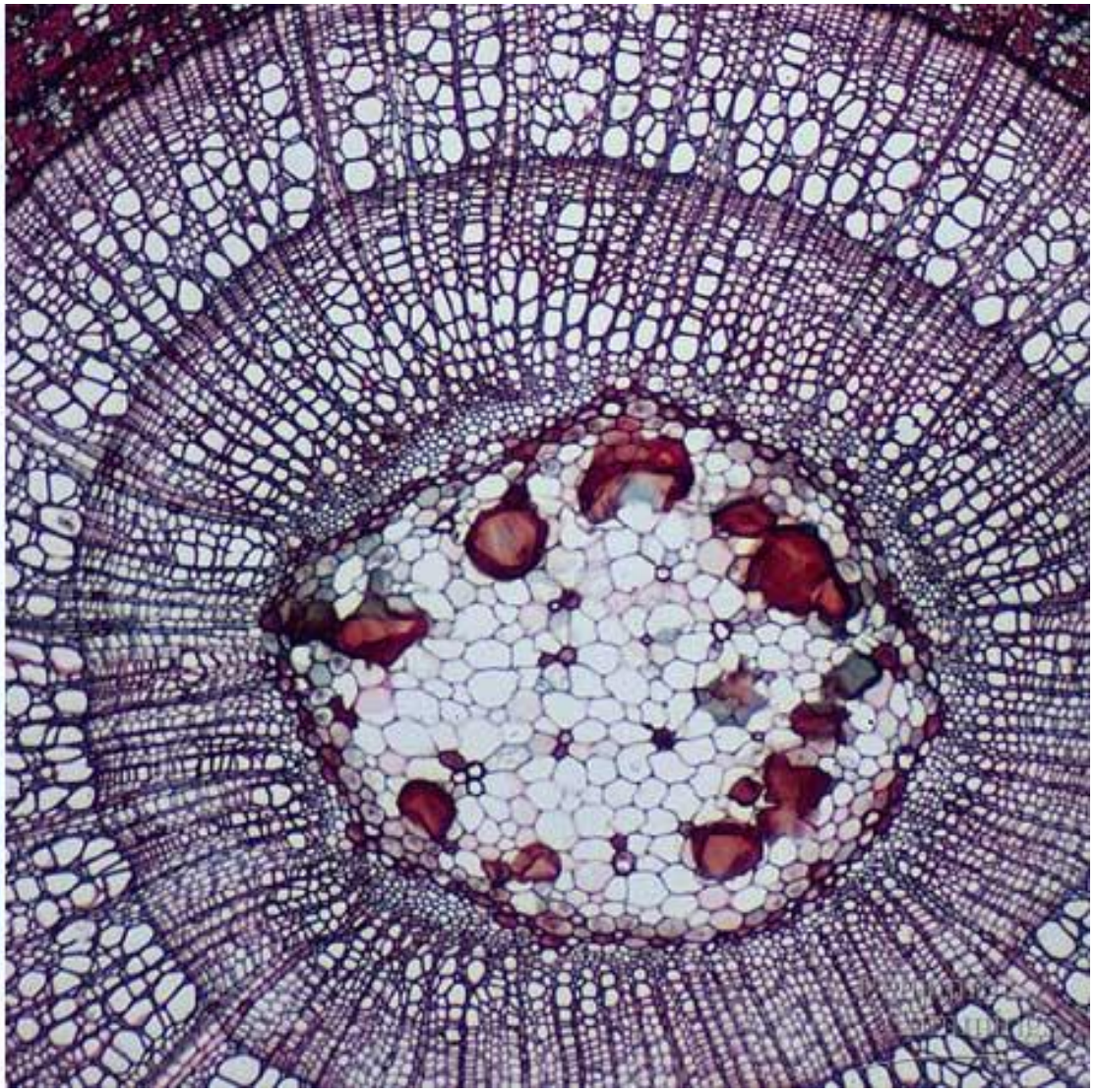




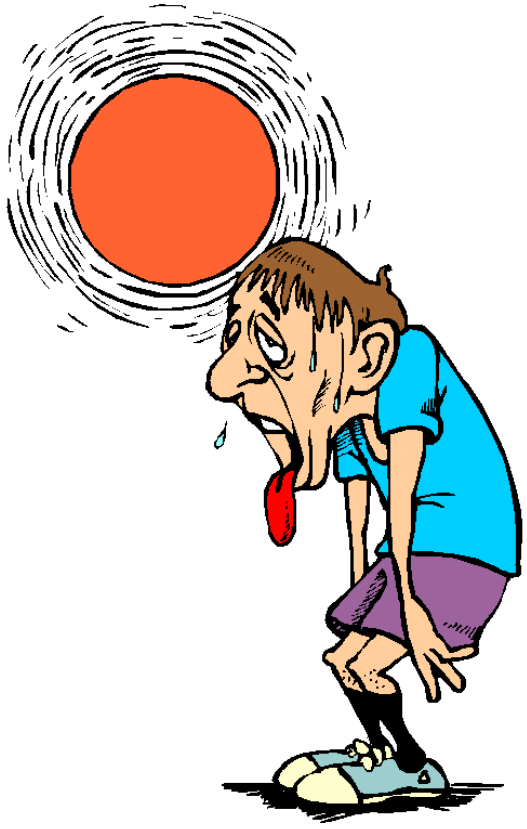




Terrenos áridos d > 3 a 5 vezes a sua altura



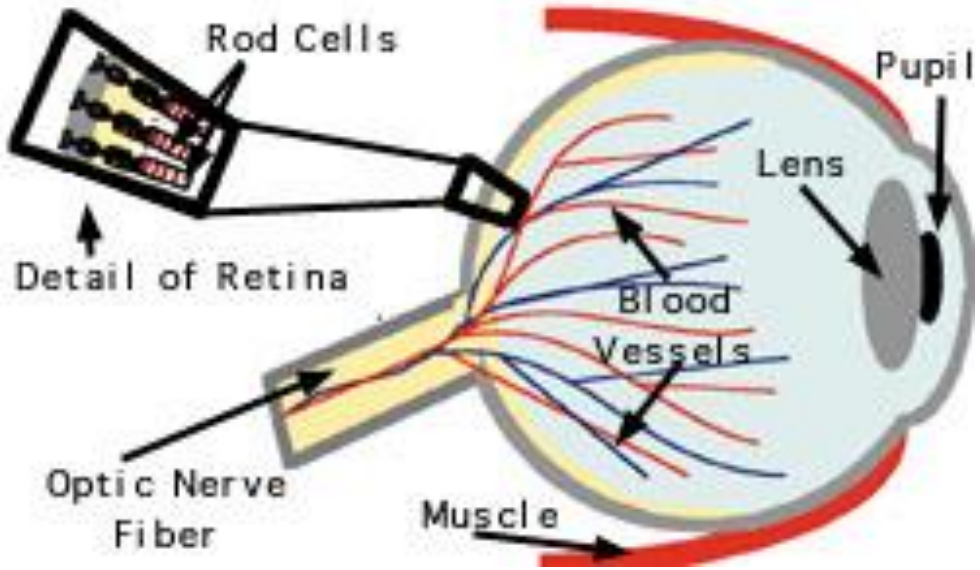
Alto calor específico e de evaporação.

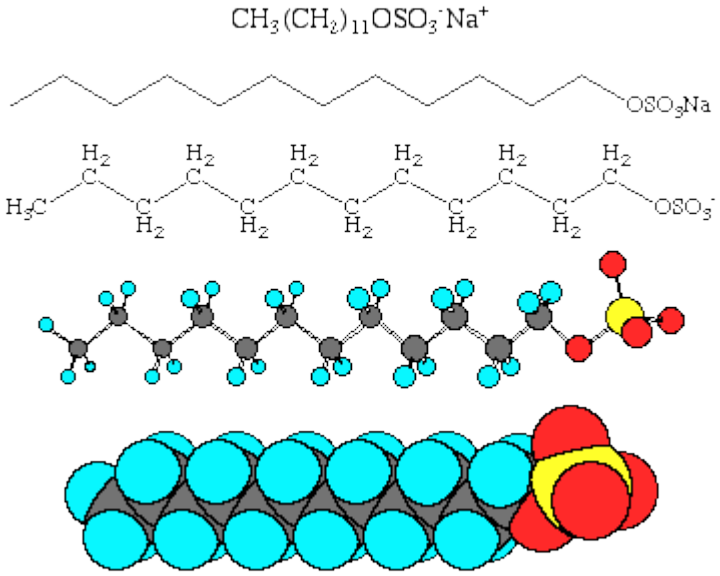


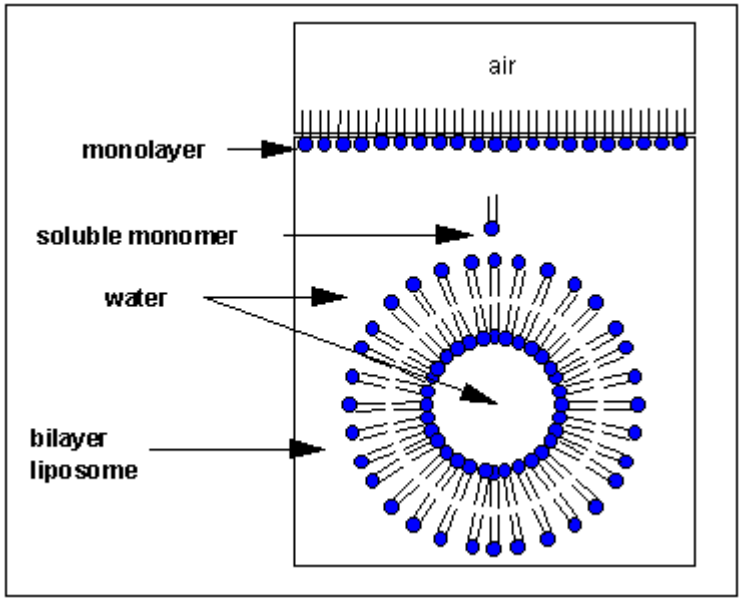
Calor Específico da água : 1 cal/g/^{o}C

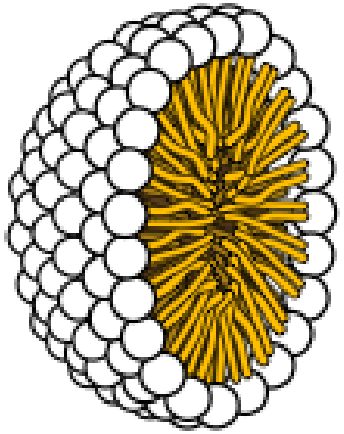
Água é Transparente

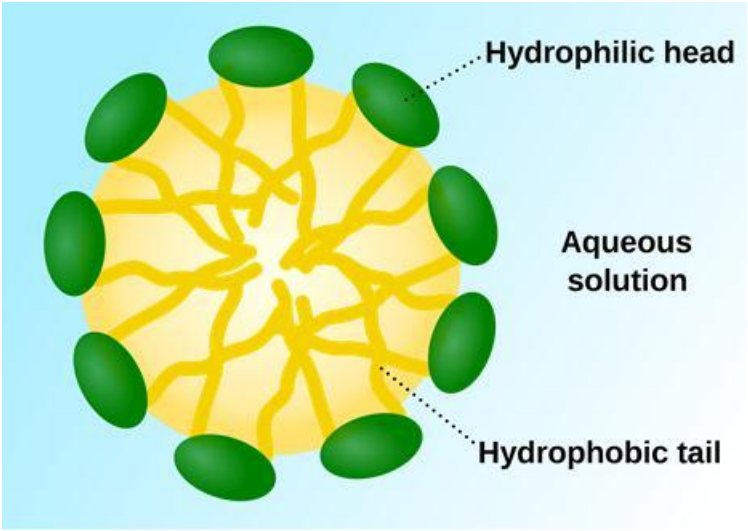
- **A luz é transmitida através da água.**
  - **Plantas aquáticas recebem a luz do sol.**
  - **A visão humana é possivel. Luz passa pelos nossos olhos e chega aos receptores celulares**




$CH_3(CH_2)_{11}OSO_3^-Na^+$
OSO_3Na
H_3C
OSO_3^-


air
monolayer
soluble monomer
water
bilayer
liposome




Hydrophilic head
Aqueous solution
Hydrophobic tail

The mathematic-thermodynamic analysis of the anomalies of water and the temperature range of life

Karl Trincher

Water Research 15(4):433 (1981)

Water between 0 and 15°C consists of a vacuum component and of 3 substantial components: a quasi-crystalline component (K), a fluid component (F) and ice-relicts (R). Together they form a colloid system. (K) forms the dispersing milieu in which (R) and (F) are included as two dispersed phases. As the temperature rises from 0 to 15°C, the (R)-component diminishes in amount while the (K)-component increases proportionally. Between 19 and 30°C (F) remains the only dispersed phase. Between 30 and 45°C water consists of two phases (F) and (K), dispersed in the vacuum component. Between 45 and 60°C (F) is the dispersing medium with (K) the dispersed phase. After 60°C, water becomes a structurally homogeneous fluid, (F). All anomalies of water, both the "continuous" ones, occurring over large temperature and pressure ranges, and the "discrete" ones appearing at 15, 30, 45 and 60°C, are the results of these changes between the (R), (K), and (F) components. The biological evolution of warm-blooded animals has resulted in forms whose life is restricted to a narrow range of temperature with an optimum at approx. **37.5°C. At this temperature water possesses its minimum of heat capacity, a low coefficient of compressibility and the maximum of structural possibilities based on combinations of its (K) and (F) components.**