

# APA ÎN SISTEMELE BIOLOGICE

# APA

→ "Matricea vieții" (Albert Szent - Györgyi)

→ Lichidul cel mai răspândit (75 %)

1937



"Dis  
else  
nob

dicină

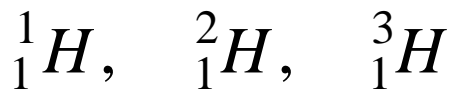


1893 - 1986

Biological Research Center Szeged

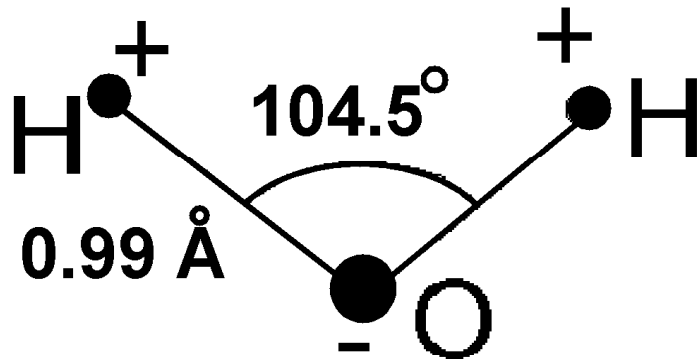
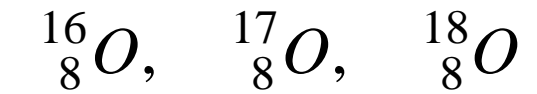
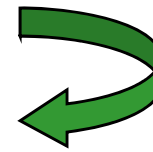
# MOLECULA DE APĂ

## STRUCTURA ATOMICĂ

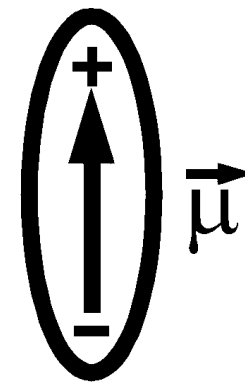


$6 \times 3 = 18$

TIPURI



$\text{D}_2\text{O}$  (1:6000)

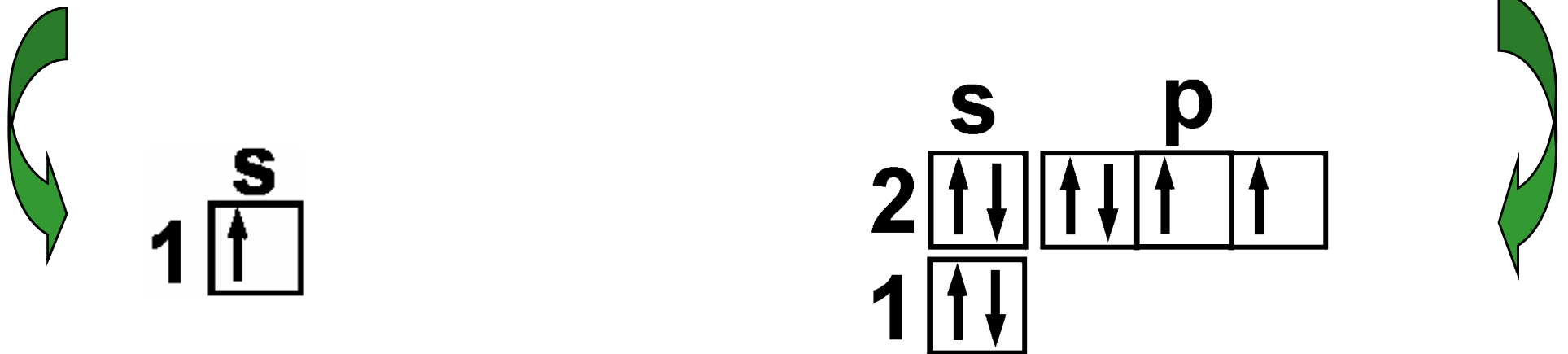


$\mu = 1.84 \text{ D}$

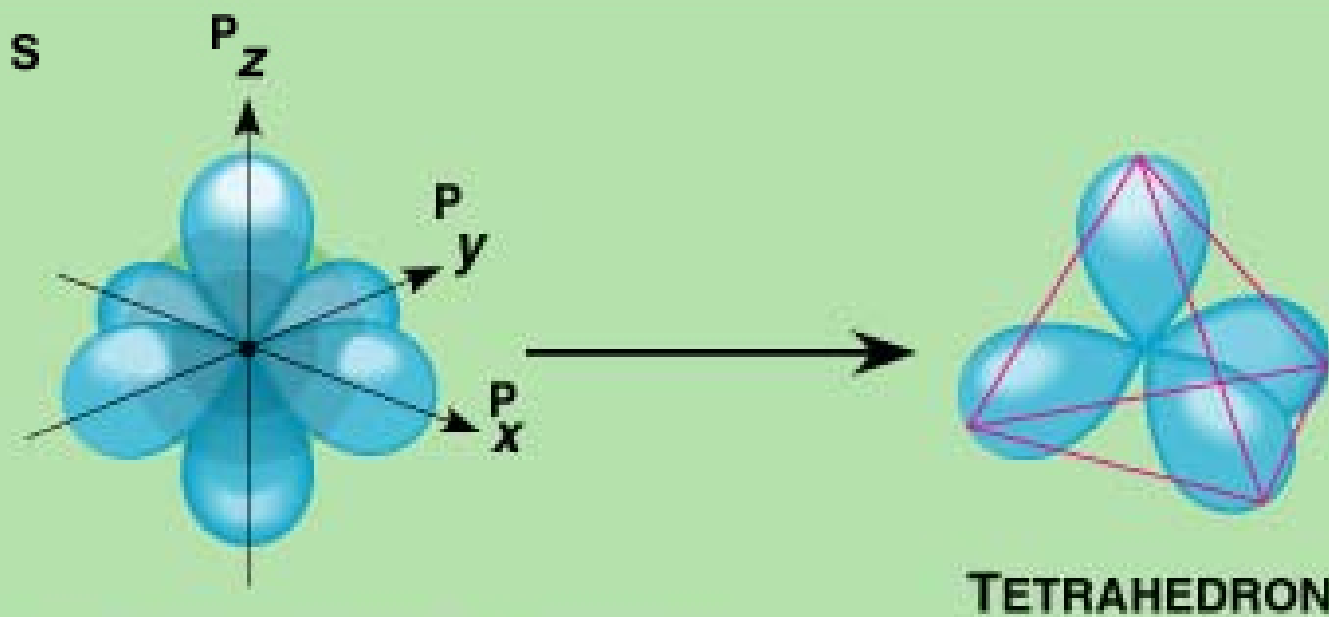
# STRUCTURA ELECTRONICĂ

H (Z = 1):  $1s^1$

O (Z = 8):  $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$

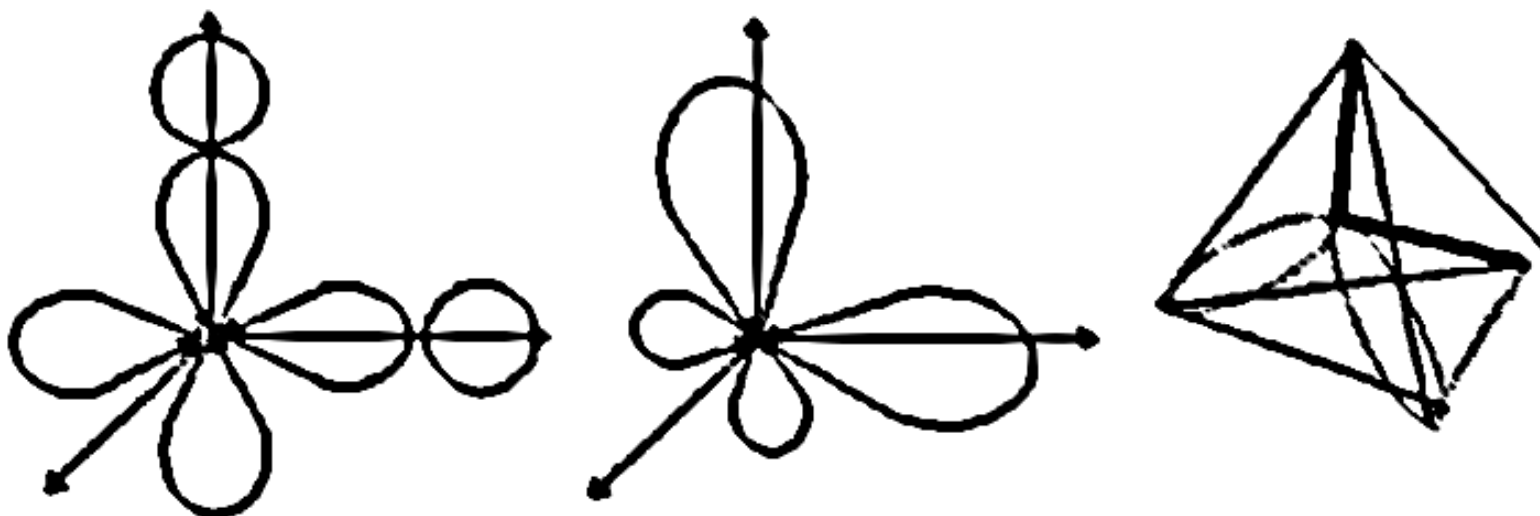
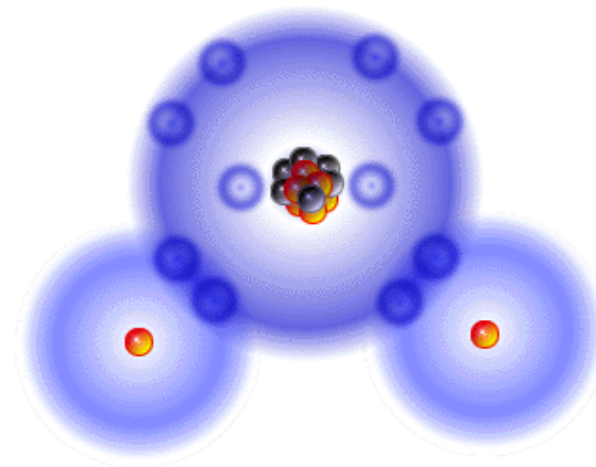


- + electronii de pe orbitalii  $2s$  și  $2p_x$  ai atomului de O - electroni neparticipanți;
- + electronii de pe orbitalii  $2p_y$  și  $2p_z$  ai atomului de O - implicați în legăturile covalente;
- + electronul de pe orbitalul  $1s$  al atomului de H - se găsește mai aproape de O

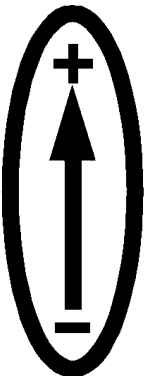


(a) Hybridization of orbitals

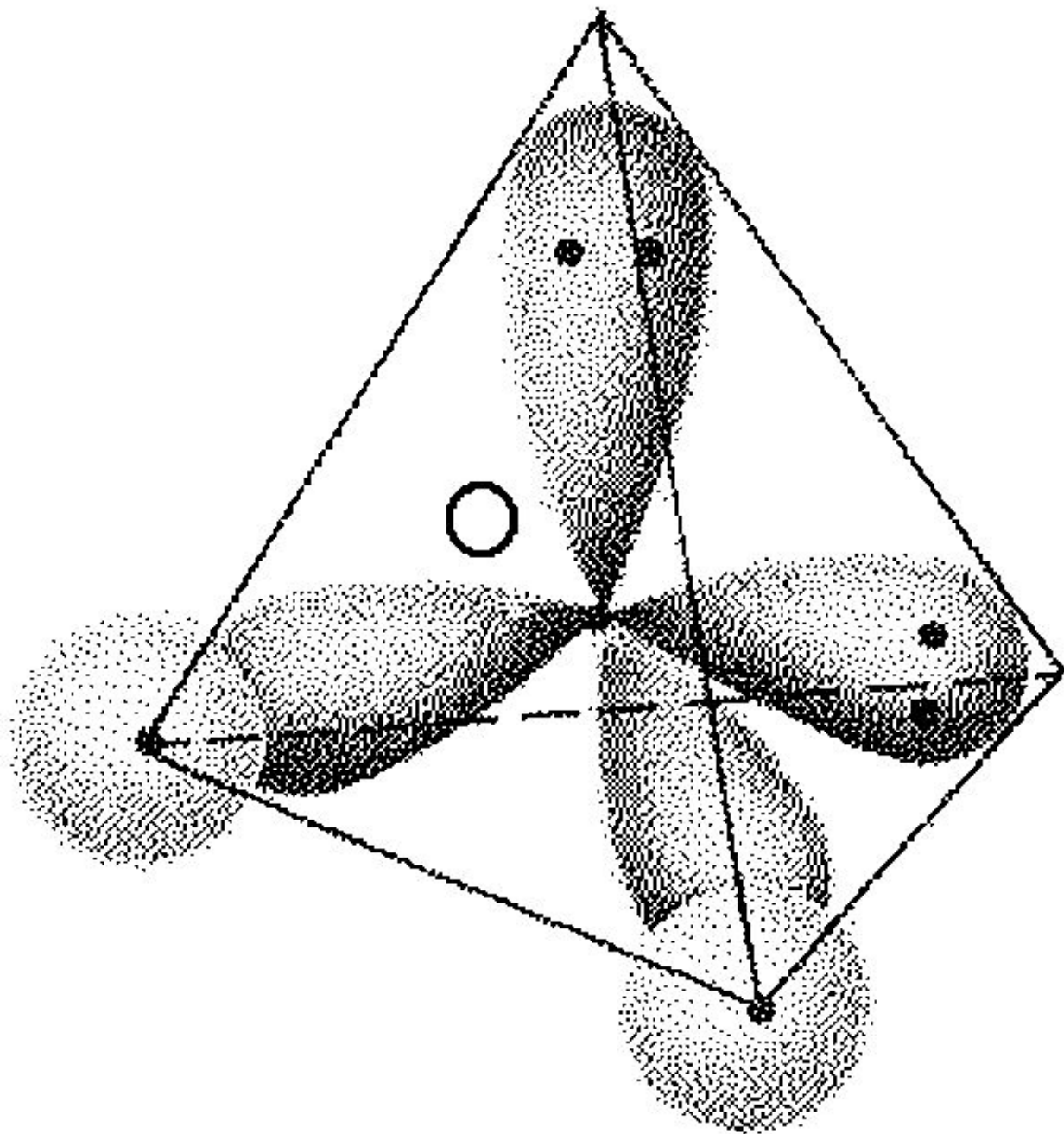
Water Molecule



hibridizare  $sp^3$

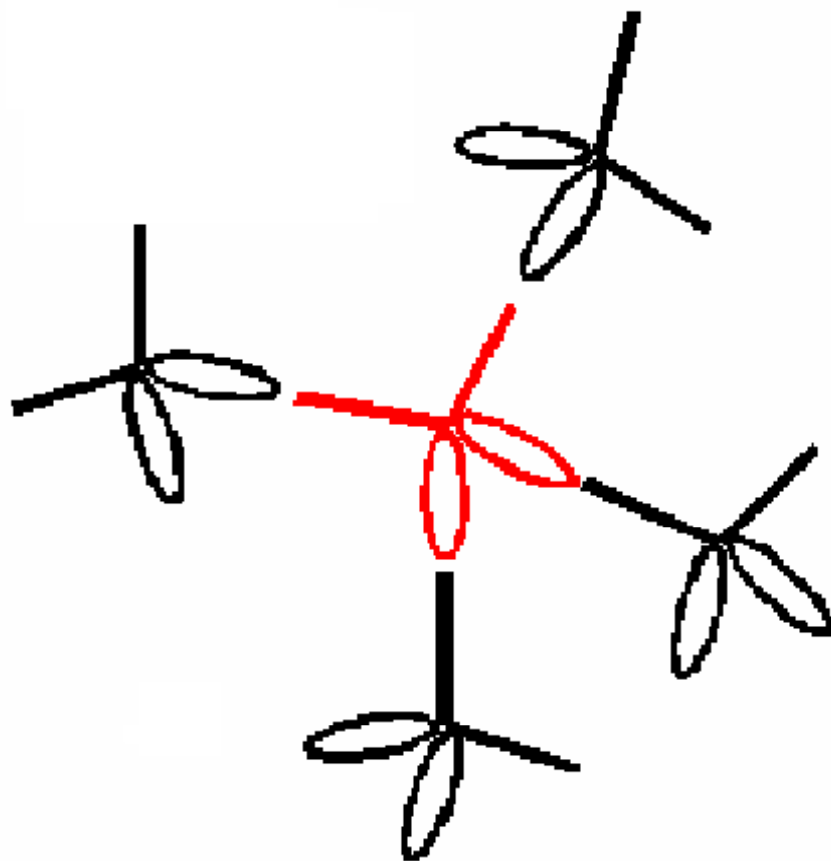
  
 $\mu = 1.84 \text{ D}$

H

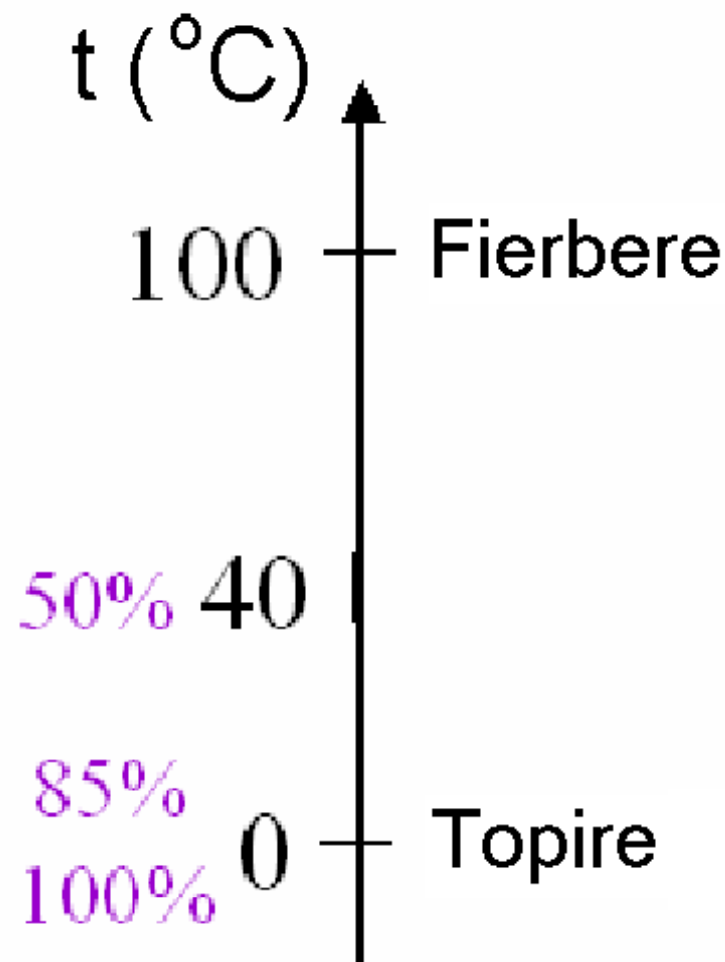


H

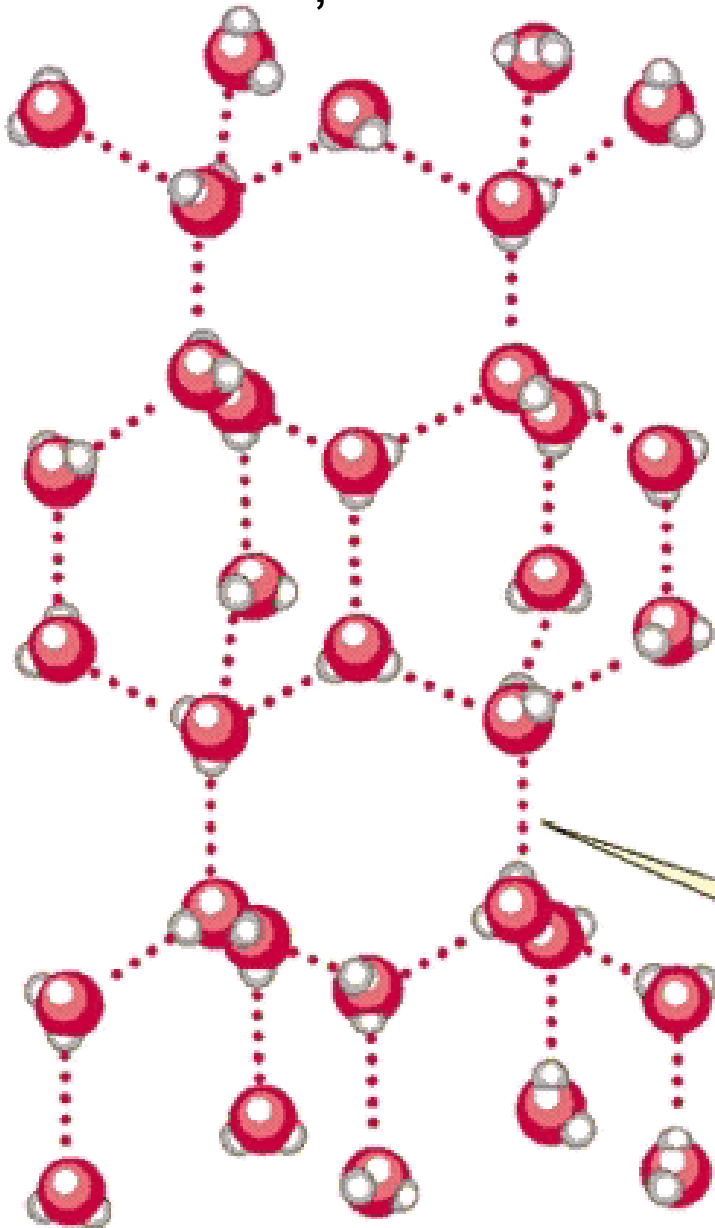
# LEGĂTURI DE HIDROGEN



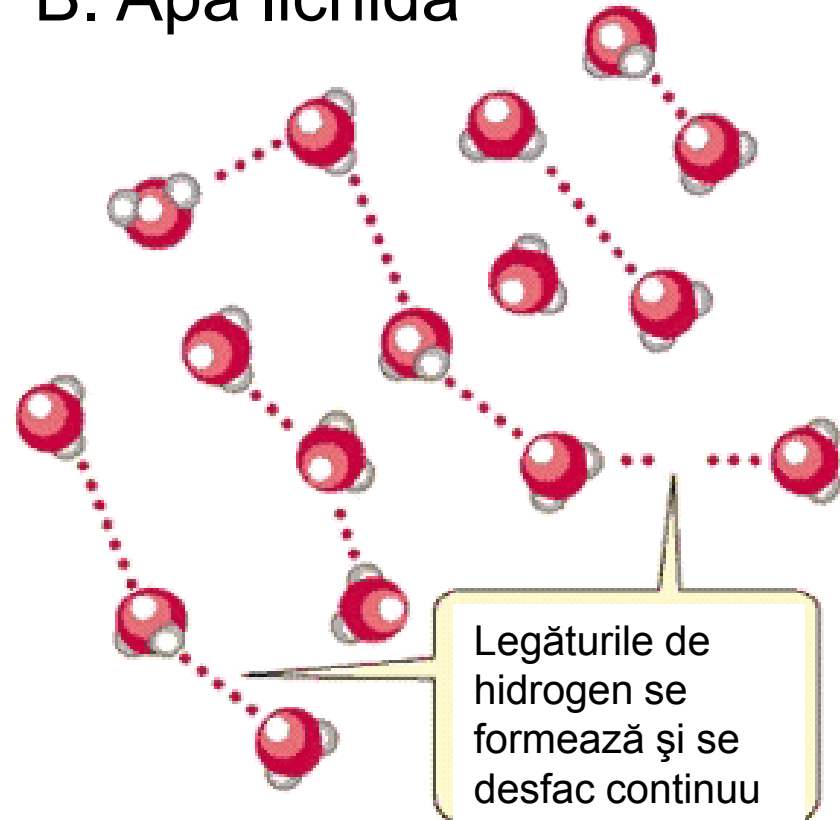
Distanța O - O : 2.76 Å



## A. Gheață

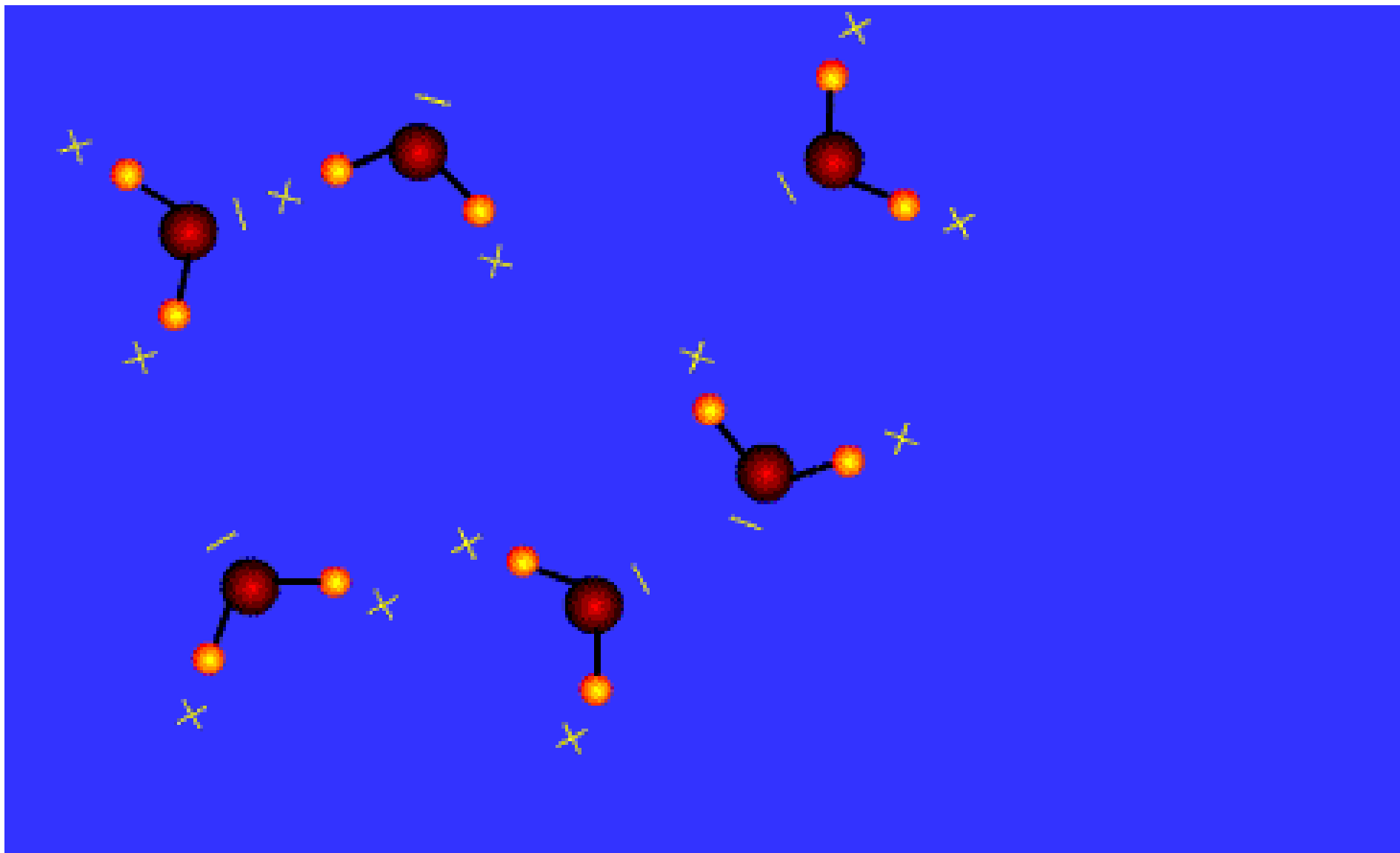


## B. Apă lichidă



Structura hexagonală a gheții se datorează legăturilor de hidrogen





# Călătoria lui Gulliver în Lilliput



legătura de hidrogen: 4.3 kcal/mol

# PROPRIETĂȚI FIZICE ALE APEI

## □ STĂRI DE AGREGARE

- SOLIDĂ ( $t < 0\text{ }^{\circ}\text{C}$ )
- LICHIDĂ ( $0 - 100\text{ }^{\circ}\text{C}$ ) ( $p = 1\text{ atm}$ )
- GAZOASĂ ( $t > 100\text{ }^{\circ}\text{C}$ )

## □ CĂLDURĂ SPECIFICĂ

4185 J / kg · K (foarte mare)

$$Q = m \cdot c \cdot \Delta T$$

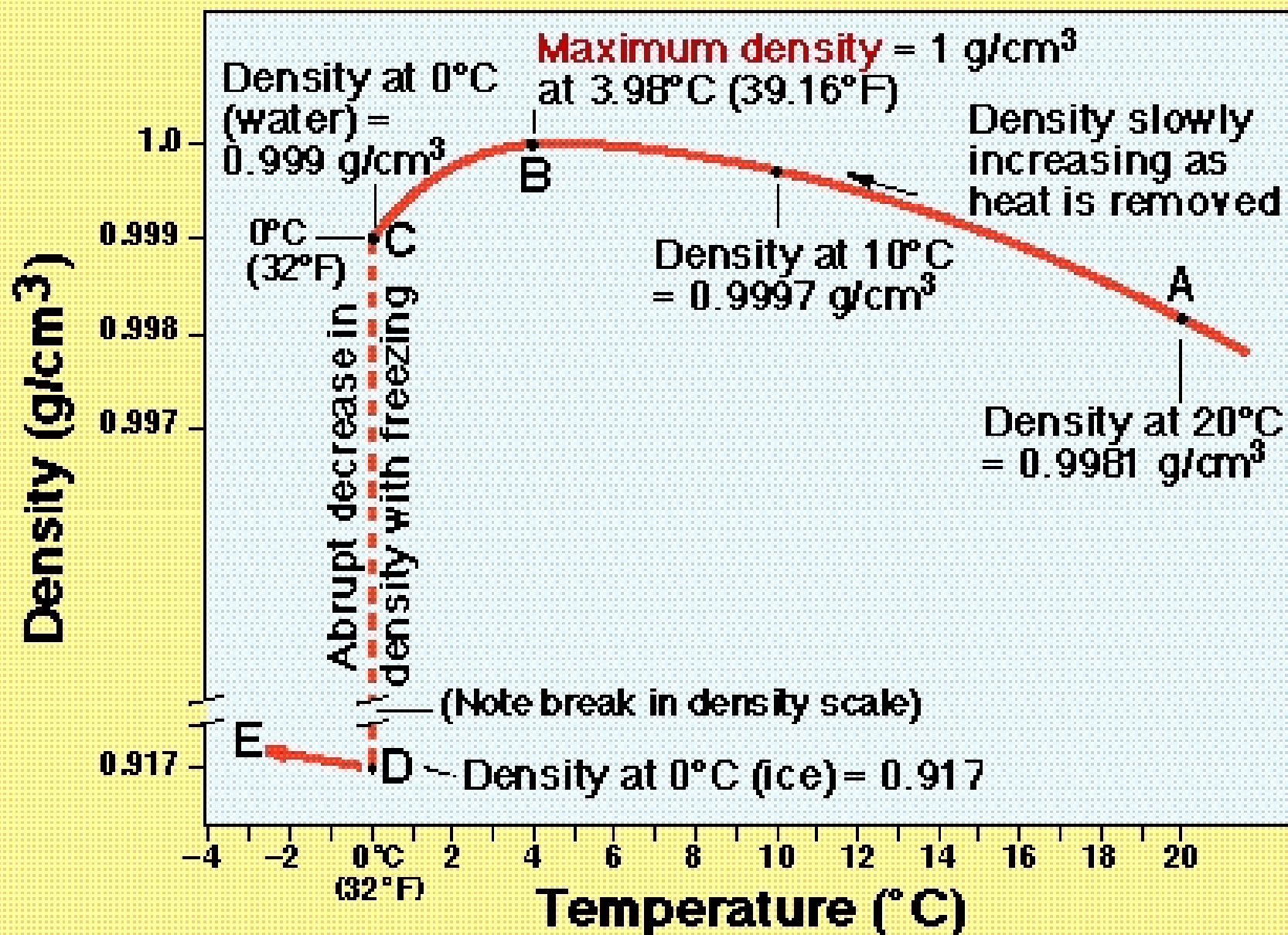
## □ CĂLDURI LATENTE SPECIFICE:

- de topire 340.000 J / kg
- de vaporizare 2.250.000 J / kg

$$Q_t = m \cdot \lambda_t$$

# □ DENSITATE

## Density vs. Temperature for Pure Water

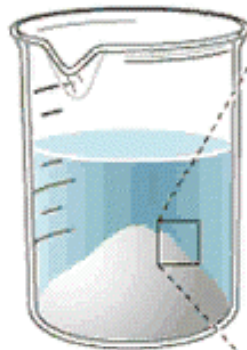


# □ PERMITIVITATE ELECTRICĂ RELATIVĂ:

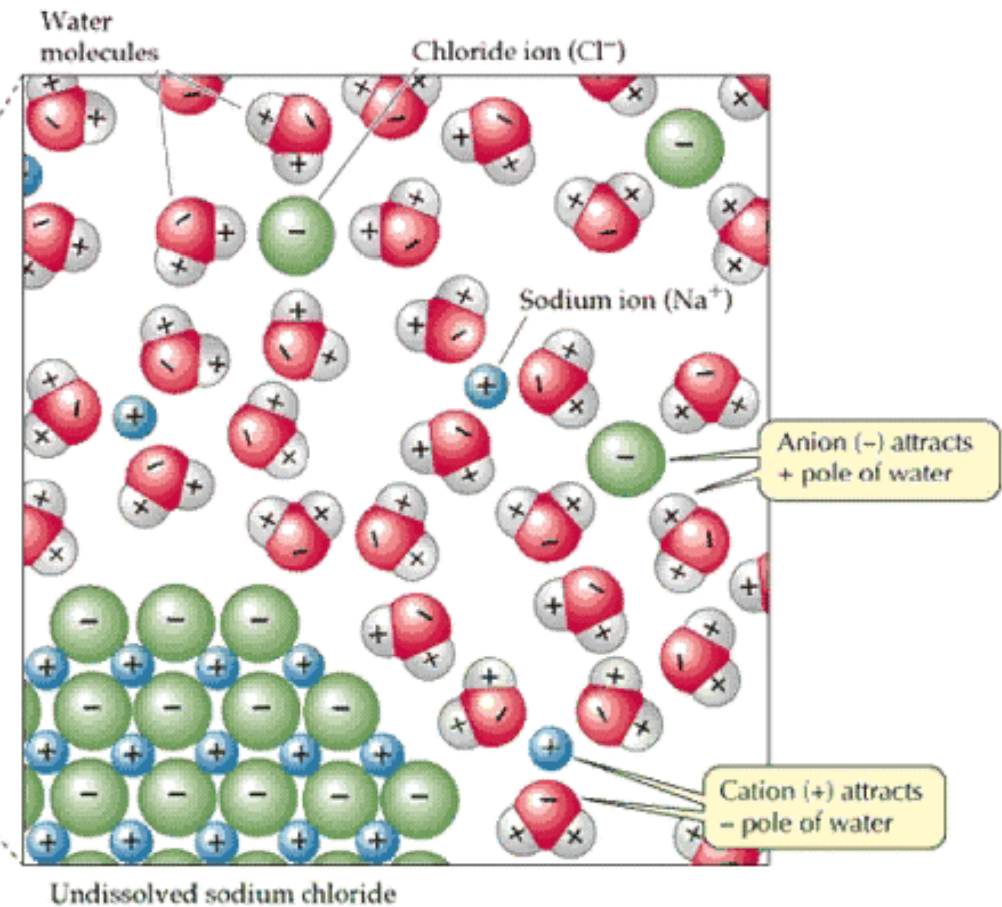
$$\epsilon_r = 80 \text{ (mare)}$$

(apa este un bun solvent al cristalelor ionice)

$$F_{\text{vid}} = \frac{1}{4\pi\epsilon_0} \cdot \frac{|q_1q_2|}{r^2}$$



$$F_{\text{apa}} = \frac{1}{4\pi\epsilon_0\epsilon_r} \cdot \frac{|q_1q_2|}{r^2} = \frac{F_{\text{vid}}}{80}$$



## □ TENSIUNE SUPERFICIALĂ

$$\sigma = 72,8 \text{ mN/m (dyn/cm)}$$

## □ PROPRIETĂȚI ELECTRICE

- ✓ rezistivitate electrică mare:  $\rho_{25} = 182 \cdot 10^3 \Omega \cdot \text{m}$
- ✓ conductivitate electrică mică:  $\sigma_{25} = 5,5 \cdot 10^{-6} \Omega^{-1} \cdot \text{m}^{-1}$
- ✓ pot fi îmbunătățite prin dizolvarea de substanțe ionice

## □ PROPRIETĂȚI DE SOLVENT

- substanțe hidrofile: compuși ionici și polari
- substanțe hidrofobe: lipide

## □ CARACTER AMFOTER

# ROLURI ALE APEI ÎN SISTEMELE VII

- + solventul universal al materiei vii;
- + reglarea presiunii osmotice;
- + mediu de desfășurare a reacțiilor biochimice;
- + reactant;
- + termoreglare;
- + mediu de transport;
- + eliminarea cataboliților;
- + protecție mecanică.