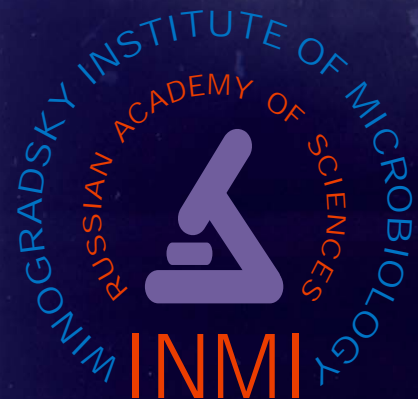


“Europa Lander workshop:  
Science goals and experiments”  
Moscow 2009

# Cryptolife and Cryptobiosphere: Triads of existence conditions

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Photo © Valery Galchenko



**UNIVERSE**

**MATTER**

**ENERGY**

**Evolution of Life is based on  
MATTER rather than energy  
fields.**

**Why ?**



Unlike energy fields, MATTER is:

stable in space,

stable in time,

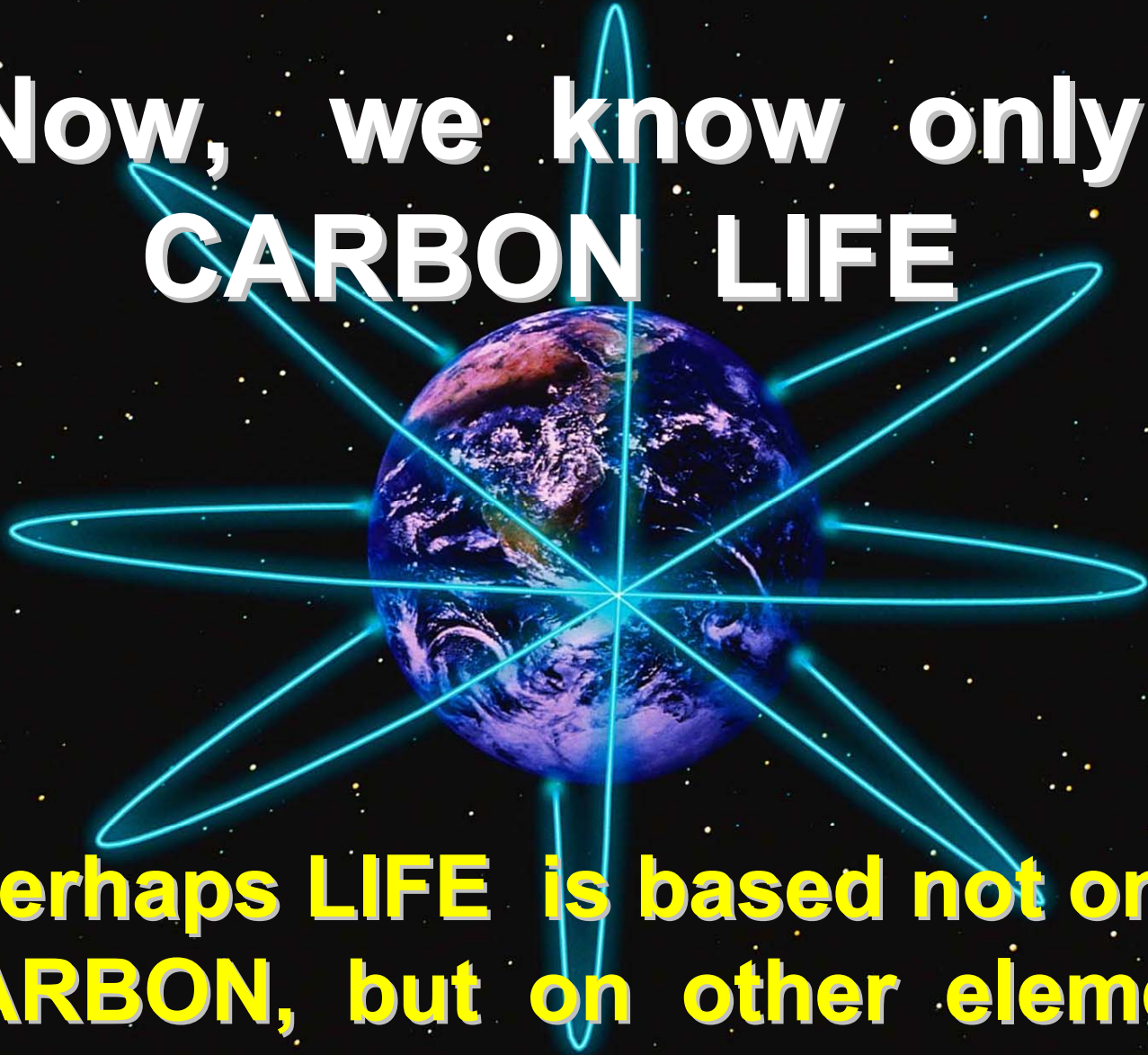
very diverse,

energy containing



**C LIFE**

**Now, we know only  
CARBON LIFE**



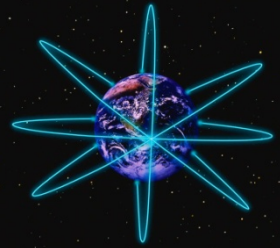
**Perhaps LIFE is based not on  
the CARBON, but on other elements?**

**Structural  
(organics)**

**Energy**

**Cofactor  
(metals)**

**GROUPS of  
BIOGENIC  
ELEMENTS**



? ? ? ? ?

<b>H</b> 1																	<b>He</b> 4
<b>Li</b>	<b>Be</b>											<b>B</b>	<b>C</b> 12	<b>N</b> 14	<b>O</b> 16	<b>F</b>	<b>Ne</b>
<b>Na</b> 23	<b>Mg</b> 27											<b>Al</b>	<b>Si</b> 28	<b>P</b> 31	<b>S</b> 32	<b>Cl</b> 35,5	<b>Ar</b>
<b>K</b> 39	<b>Ca</b> 40	<b>Sc</b>	<b>Ti</b>	<b>V</b> 51	<b>Cr</b> 52	<b>Mn</b> 55	<b>Fe</b> 56	<b>Co</b> 59	<b>Ni</b> 59	<b>Cu</b> 64	<b>Zn</b> 65	<b>Ga</b>	<b>Ge</b>	<b>As</b>	<b>Se</b>	<b>Br</b>	<b>Kr</b>
<b>Rb</b>	<b>Sr</b>	<b>Y</b>	<b>Zr</b>	<b>Nb</b>	<b>Mo</b> 96	<b>Tc</b>	<b>Ru</b>	<b>Rh</b>	<b>Pd</b>	<b>Ag</b>	<b>Cd</b>	<b>In</b>	<b>Sn</b>	<b>Sb</b>	<b>Tc</b>	<b>I</b>	<b>Xe</b>
<b>Cs</b>	<b>Ba</b>	<b>La*</b>	<b>Hf</b>	<b>Ta</b>	<b>W</b>	<b>Re</b>	<b>Os</b>	<b>Ir</b>	<b>Pt</b>	<b>Au</b>	<b>Hg</b>	<b>Tl</b>	<b>Pb</b>	<b>Bi</b>	<b>Po</b>	<b>At</b>	<b>Rn</b>
<b>Fr</b>	<b>Ra</b>	<b>Ac*</b>	<b>Rf</b>	<b>Db</b>	<b>Sg</b>	<b>Bh</b>	<b>Hs</b>	<b>Mt</b>	<b>Ds</b>	<b>Rg</b>							





# C - LIFE

## Planetary Level Triad

- THE PRESENCE of SPHERES (LITHO-, HYDRO- and/or ATMOSPHERE).
- MODERATE and STABLE ENVIRONMENTAL CONDITIONS.
- LONG-LASTING TEMPORALITY of the PLANET  
(at least 0.5-1 billion years).

A wide-angle landscape photograph of a coastal region. In the background, a range of rugged mountains with patches of snow or ice stretches across the horizon under a blue sky with wispy clouds. In the middle ground, a body of water, likely a fjord or bay, is visible. The foreground features a winding, muddy-brown river or stream that flows through a flat, brownish landscape. Patches of white snow or ice are scattered across the terrain, particularly along the edges of the water and in the lower right. Three text labels with red circular icons are overlaid on the image: 'ATMOSPHERE' in the upper right, 'HYDROSPHERE' on the left side, and 'LITHOSPHERE' in the lower right.

● **ATMOSPHERE**

● **HYDROSPHERE**

● **LITHOSPHERE**



# Life Level Triad



**WATER**



**CARBON**



**ENERGY**

# WATER

## Why water ?

- It's the most simple compound most widespread in the Universe.
- It has moderate range of temperatures of aggregate changes.
- It's a multi-purpose unaggressive solvent.
- It consists of structural and energetic biogenic elements (oxygen and hydrogen) simultaneously.



# CARBON

## Why carbon ?

- It's one of the most widespread light elements in the Universe.
- It forms stable and labile polycarbons and compounds with other light elements.
- It forms stable compounds of three aggregate states in moderate environments.
- Carbon compounds dissolve in water in moderate environments.
- It forms an extreme diversity of labile compounds !!!



# ENERGY



- Nuclear ENERGY is not suitable for the existence of Life, since penetrating radiation destroys its material matrix quite easily.
- Due to its nonquantized state, dissipative heat flux is incapable for vector-mediated transfer in matter.


Only the moderate quantum energy of stellar radiation and chemical bonds can combine with labile organic molecules.

# C - LIFE

## TRIAD OF ENVIRONMENTAL CONDITIONS



- Availability of water-soluble mineral compounds.
- Temperature range from -8 to +121° C (-18°C??? and ~~+180-250° C~~)
- Pressure - ~0 - 1100 atm. (>1100 atm. ???)

- 
- The background of the slide is a deep space image featuring a vibrant nebula with shades of blue, purple, and pink, set against a black field filled with numerous stars. A thick, bright yellow border frames the entire content area.
- ① LIFE – naturally determined phase of UNIVERCE evolution.
  - ① LIFE may be only C-LIFE.
  - ① C-LIFE is always protected by 1-3 planetary spheres.
  - ① On planets with 1-2 spheres Life is CRYPTOLIFE.
  - ① CRYPTOLIFE = MICROORGANISMS
  - ① CRYPTOLIFE – widespread display of C-LIFE.

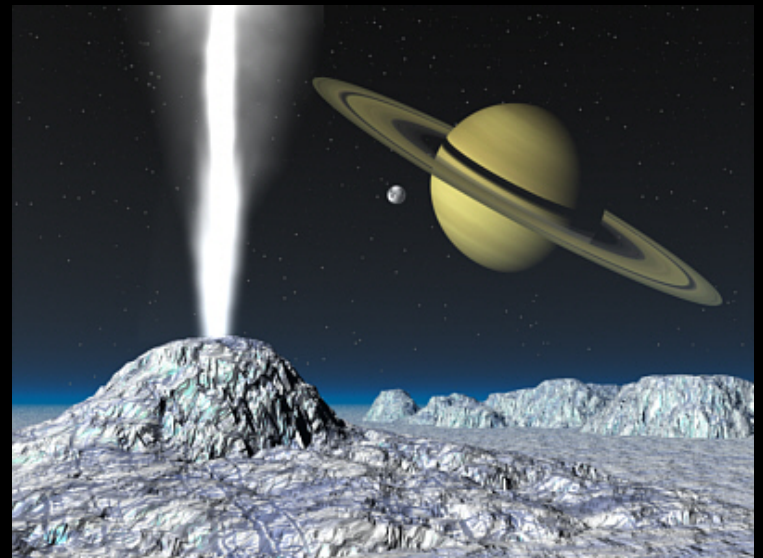
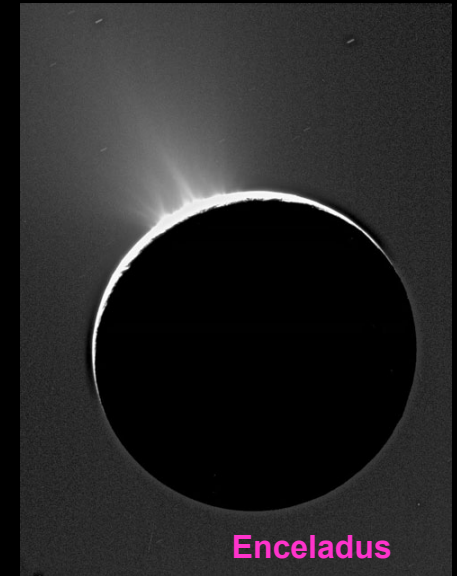
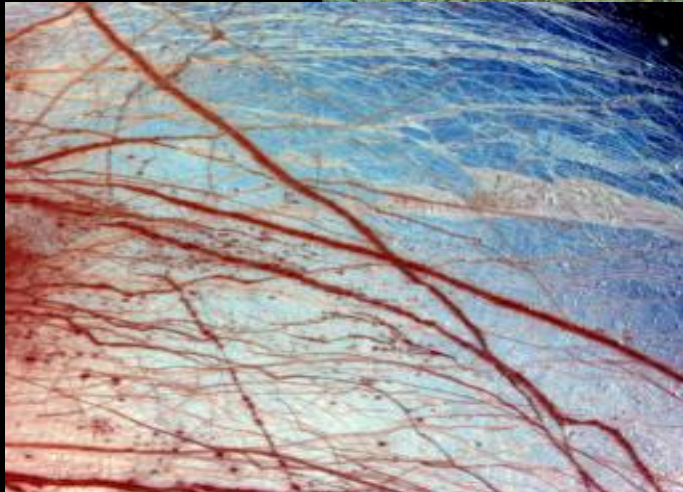
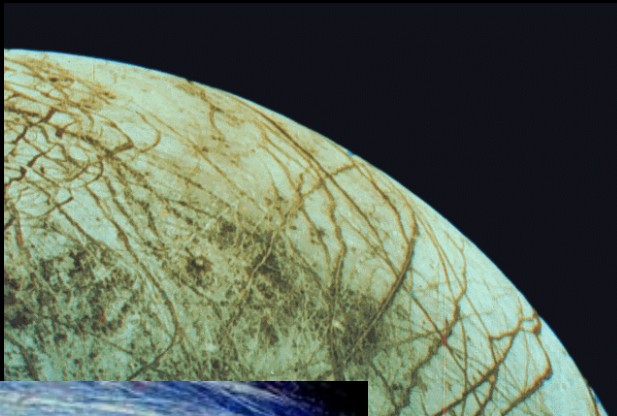
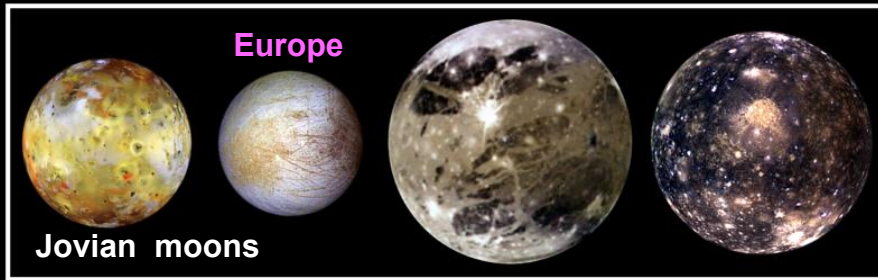


The background of the image is a deep space scene featuring a large, colorful nebula with swirling patterns of red, orange, and blue. Numerous bright stars are scattered across the dark cosmic background, some appearing as sharp points of light and others as soft, glowing spheres. The overall atmosphere is one of vastness and mystery.

# **CRYPTOLIFE - UNIVERSAL PHENOMENON**

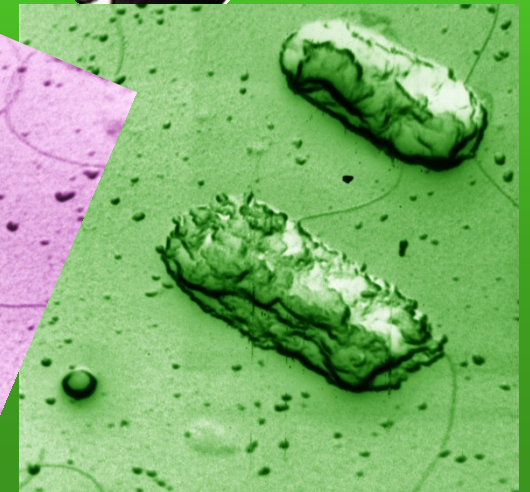
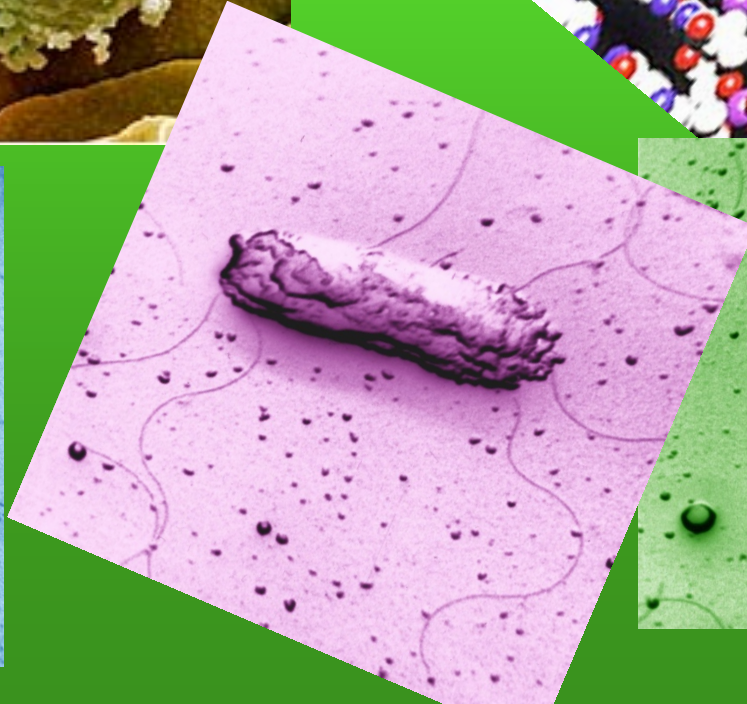
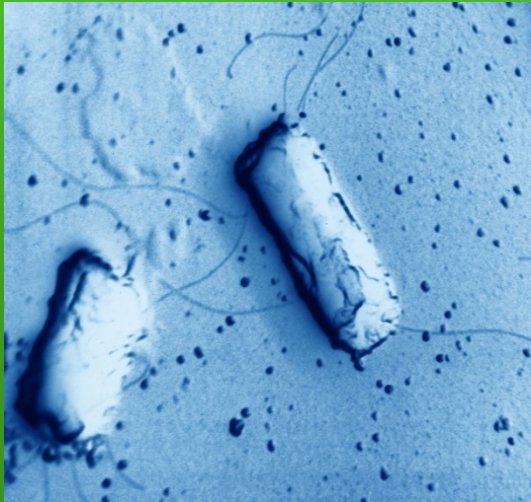
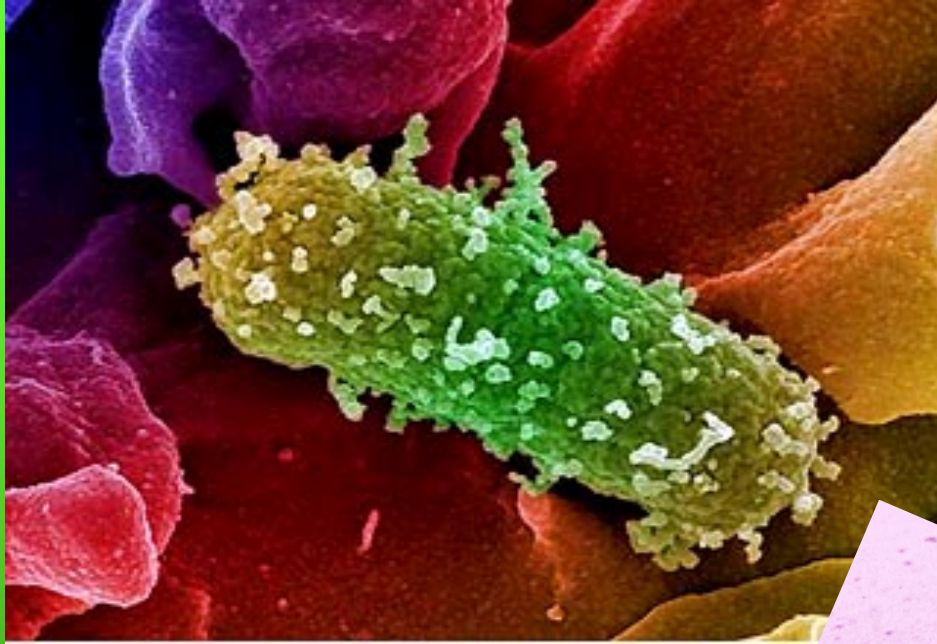


# ENCELADUS and EUROPE



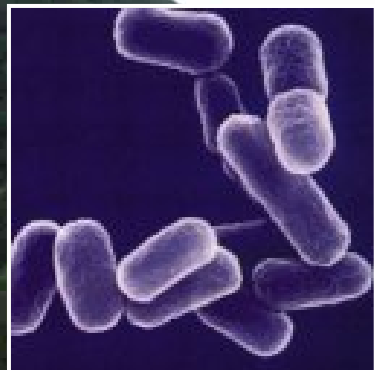


# OMNIPRESENT MICROORGANISMS: ORIGINATION OF C-LIFE ON EARTH



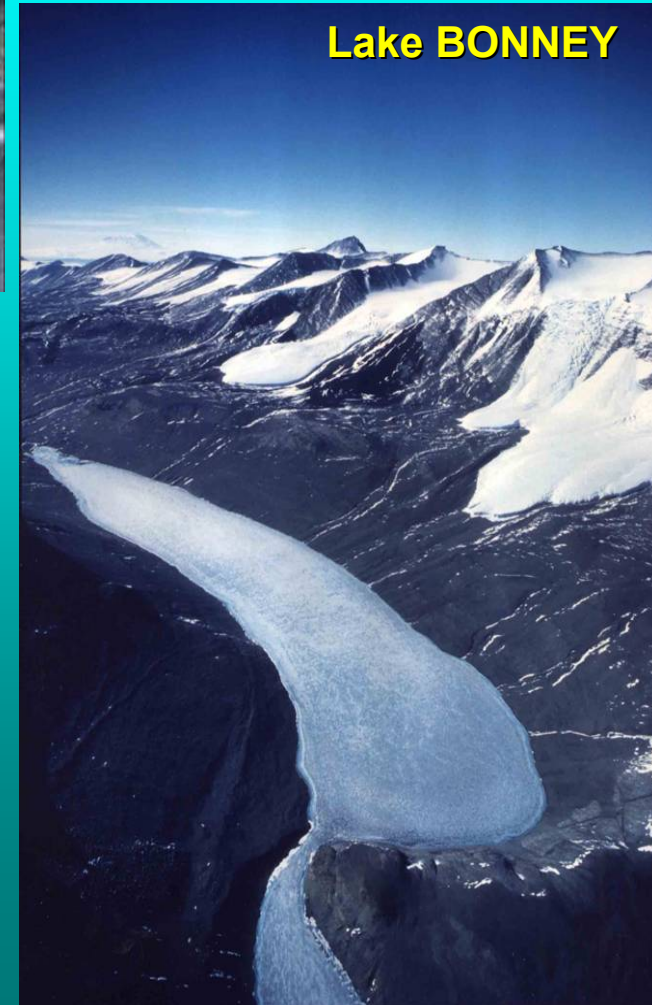


# GAYSER VALLEY. KAMCHATKA





# PERENNIALLY ICE-COVERED LAKES



# UNDEGROUND NANOBACTERIA

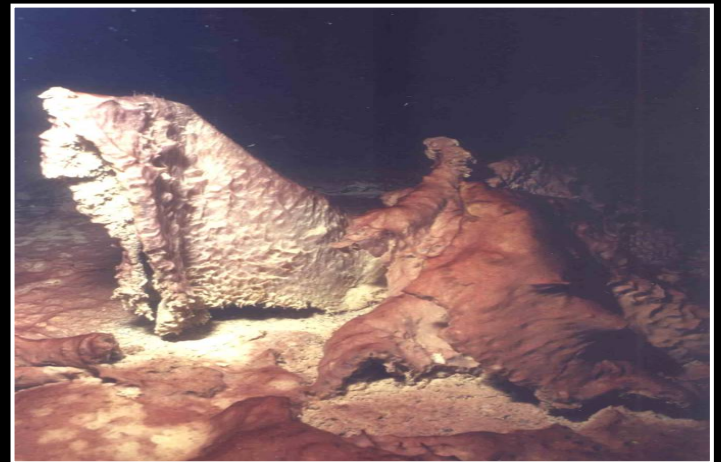
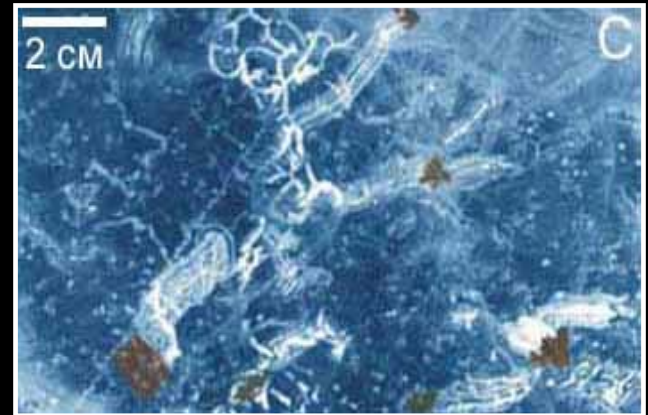


**CRYPTOLIFE on the EARTH**





# Bacterial mats

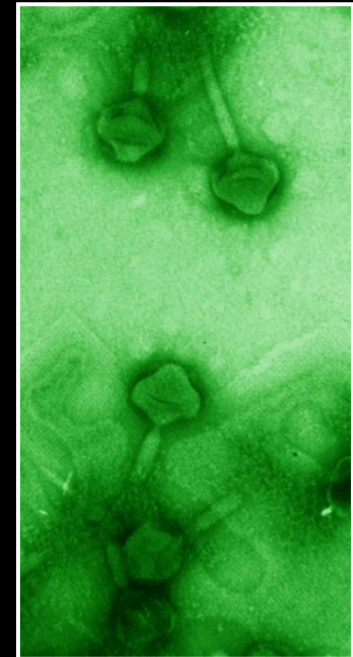
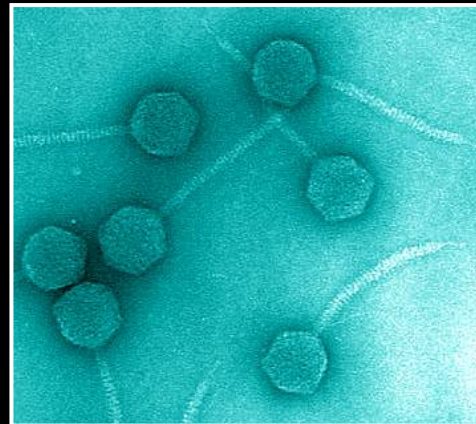
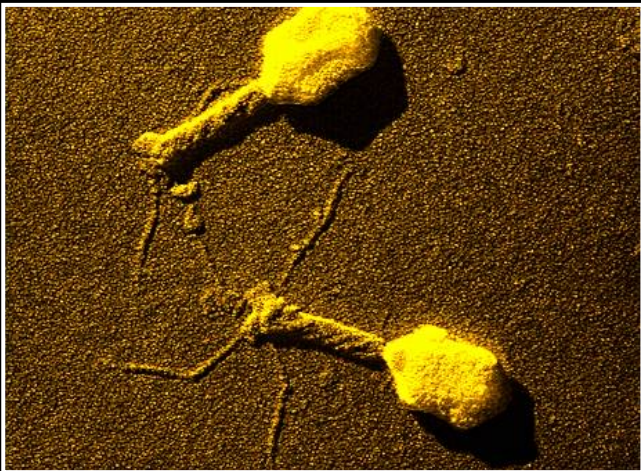
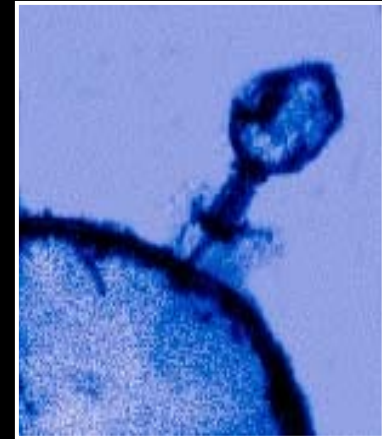
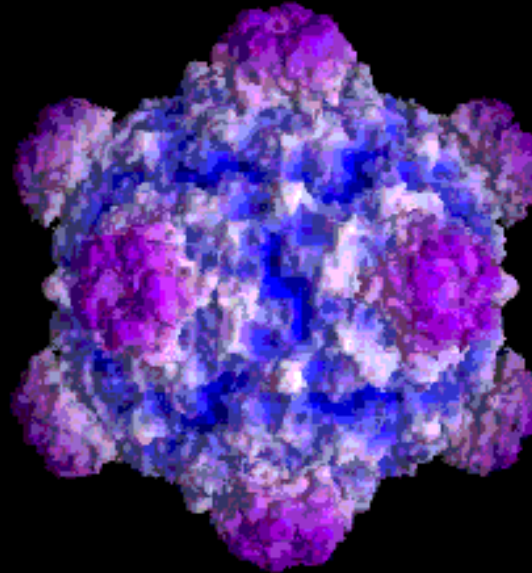
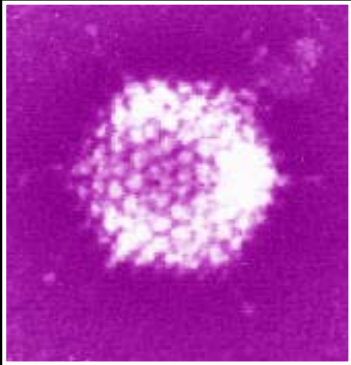


# BACTERIAL PLANKTON





# BACTERIOPHAGES





# CRYPTOMICROBS

## on EUROPE - POTENTIAL

### ANAEROBES !!!

#### CHEMOLITHOTROPHS

**Methanogens**

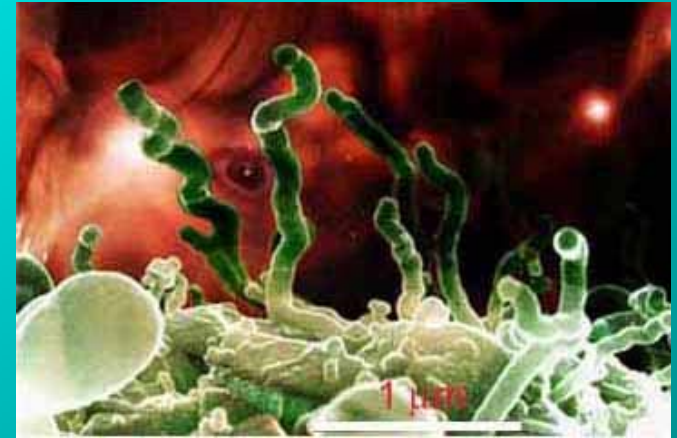
**Acetogens**

**Hydrogen-reducers**

**Denitrifiers**

**Nitrate-reducers**

**Iron-reducers**



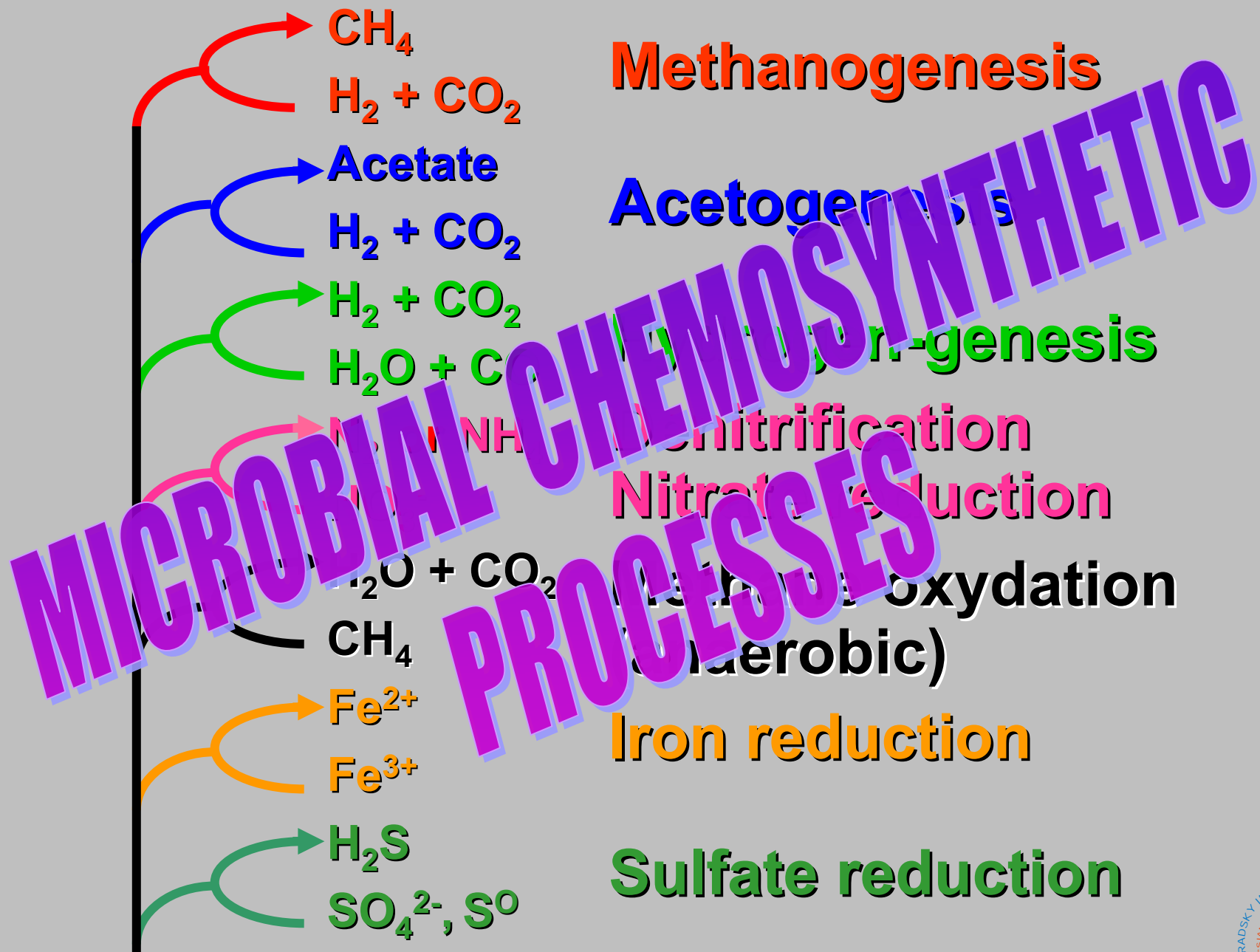
#### ORGANOTROPHS

**Hydrolytic**

**Fermenting**

**Ammonifiers**

**Denitrifiers**

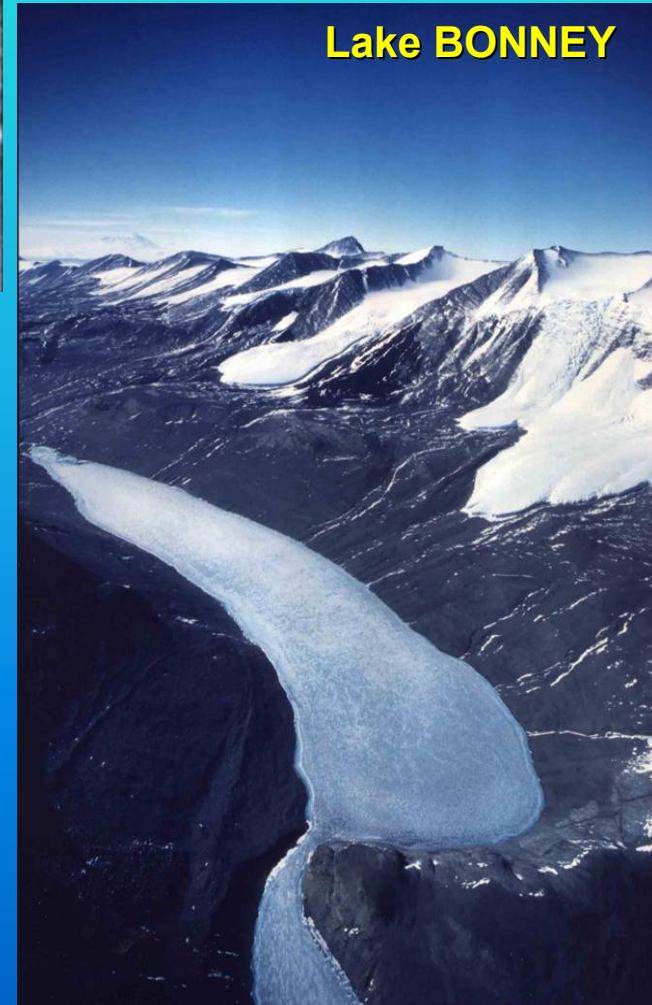




# PERENNIALLY ICE-COVERED LAKES



Lake WHITE SMOKES

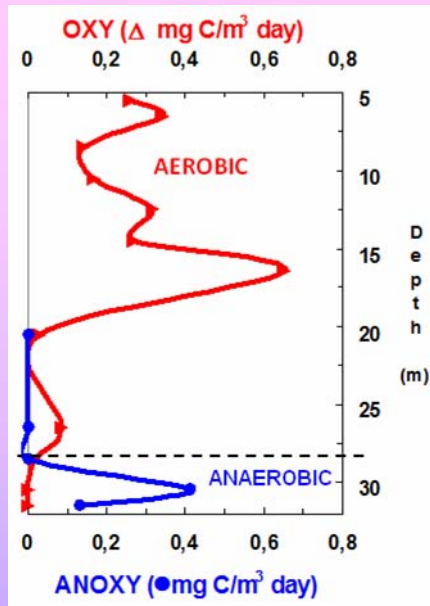


Lake BONNEY

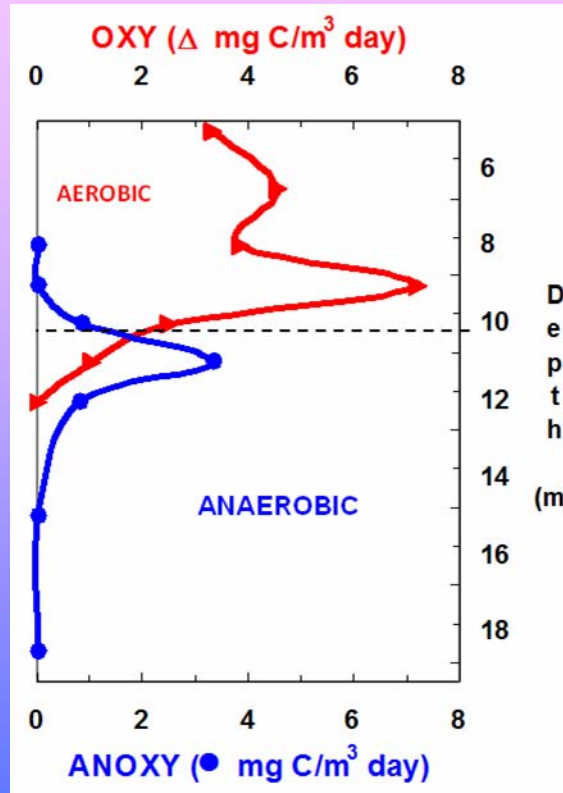
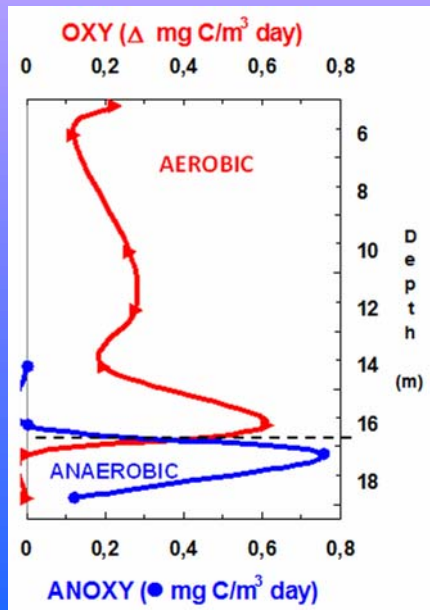


Lake FRYXELL

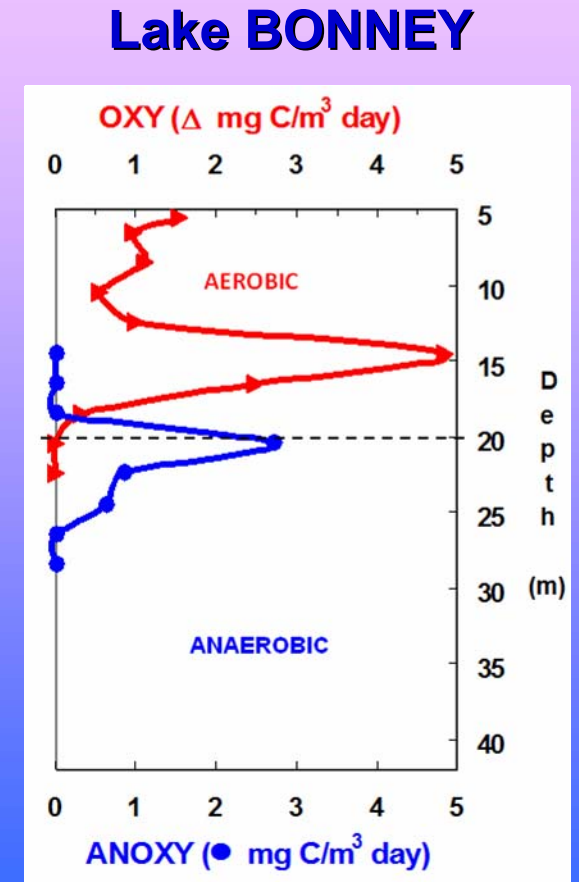
# PHOTOSYNTHESIS



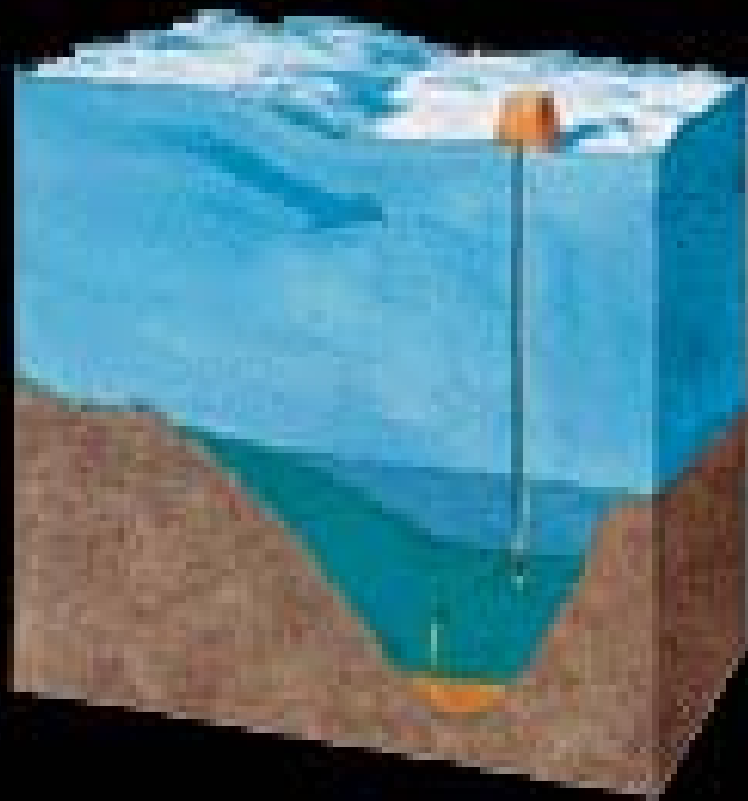
Lake HOARE



Lake FRYXELL









## HYDRO-CHEMICAL

Temperature, pH, Eh, gases, minerals

## STABLE-ISOTOPIC (MASS-SPECTROMETRIC)

D,  $^{13}\text{C}$ ,  $^{34}\text{S}$ ,  $^{18}\text{O}$ ,  $^{15}\text{N}$

## CHROMATOGRAPHIC, SPECTROMETRIC

Organic compounds

(proteins, lipides, sugars, nucleotides)

# METHODS

AUTOTROPHS:  $^{14}\text{CH}_4$ -genesis,  $^{14}\text{CO}_2$ -fixation,  $^{14}\text{C}$ -assimilation,  $^{35}\text{SO}_4$ -reduction

HETEROTROPHS:  $^{14}\text{C}_{\text{opr}}$ -mineralization,  $^3\text{H}$ -thimidin-incorporation

## CLASSIC MICROBIOLOGICAL

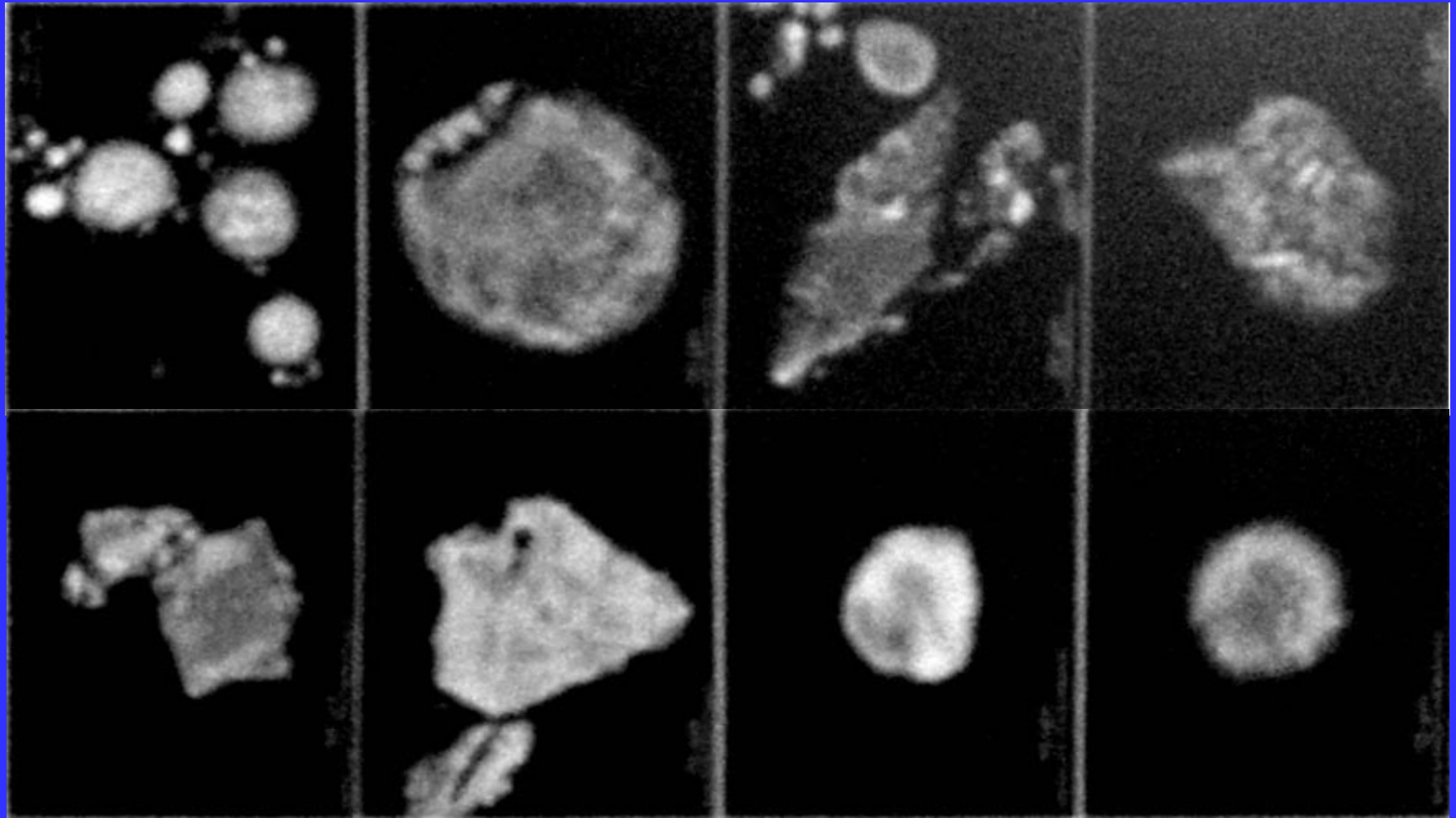
Microscopy, cultivation

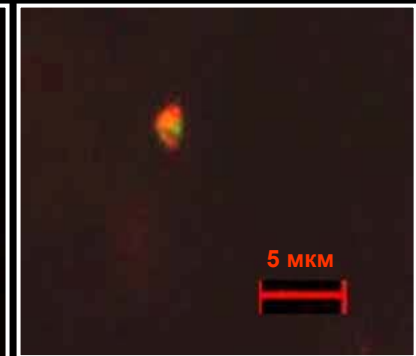
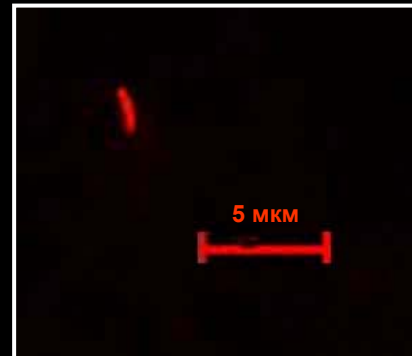
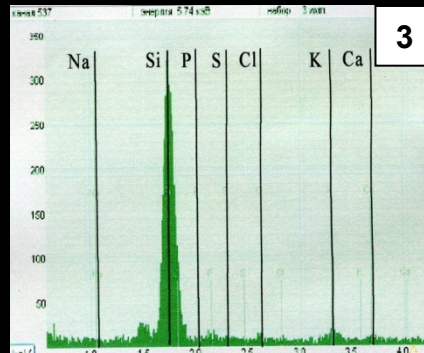
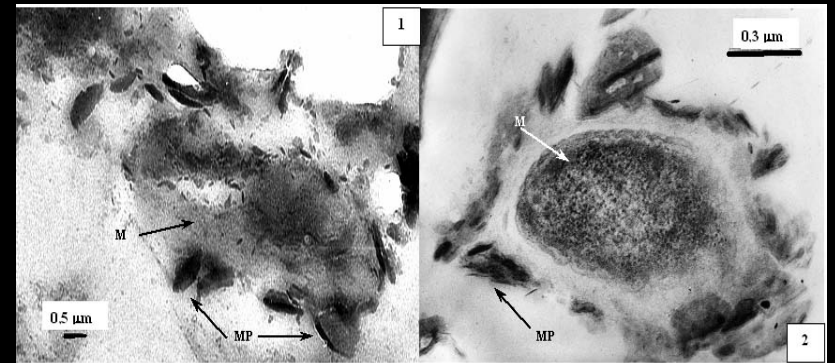
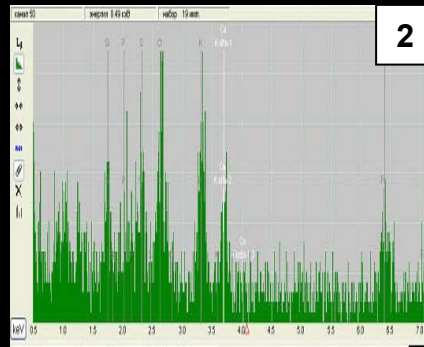
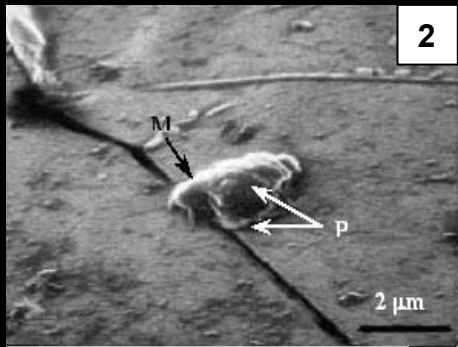
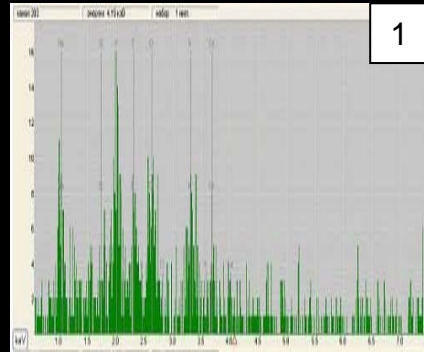
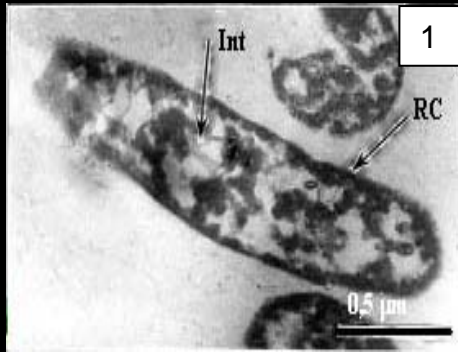
## MOLECULAR-BIOLOGICAL

PCR, FISH, probes to Rubisco and other genes



# SPHERULES in ANTARCTIC ICE







# THANKS !

